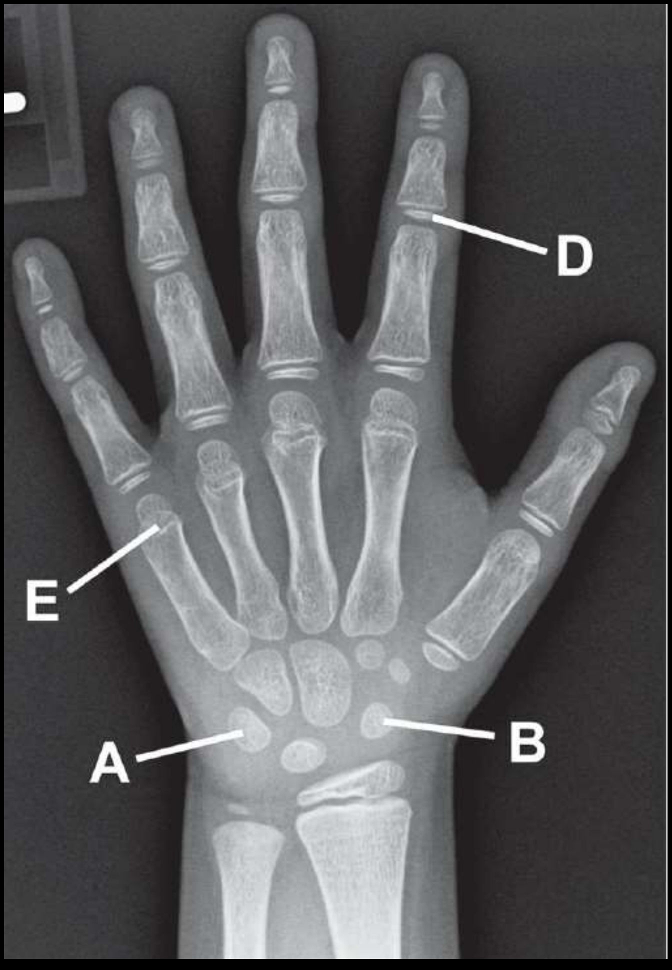
UPPER LIMB



CONTENTS

PLAIN FILM

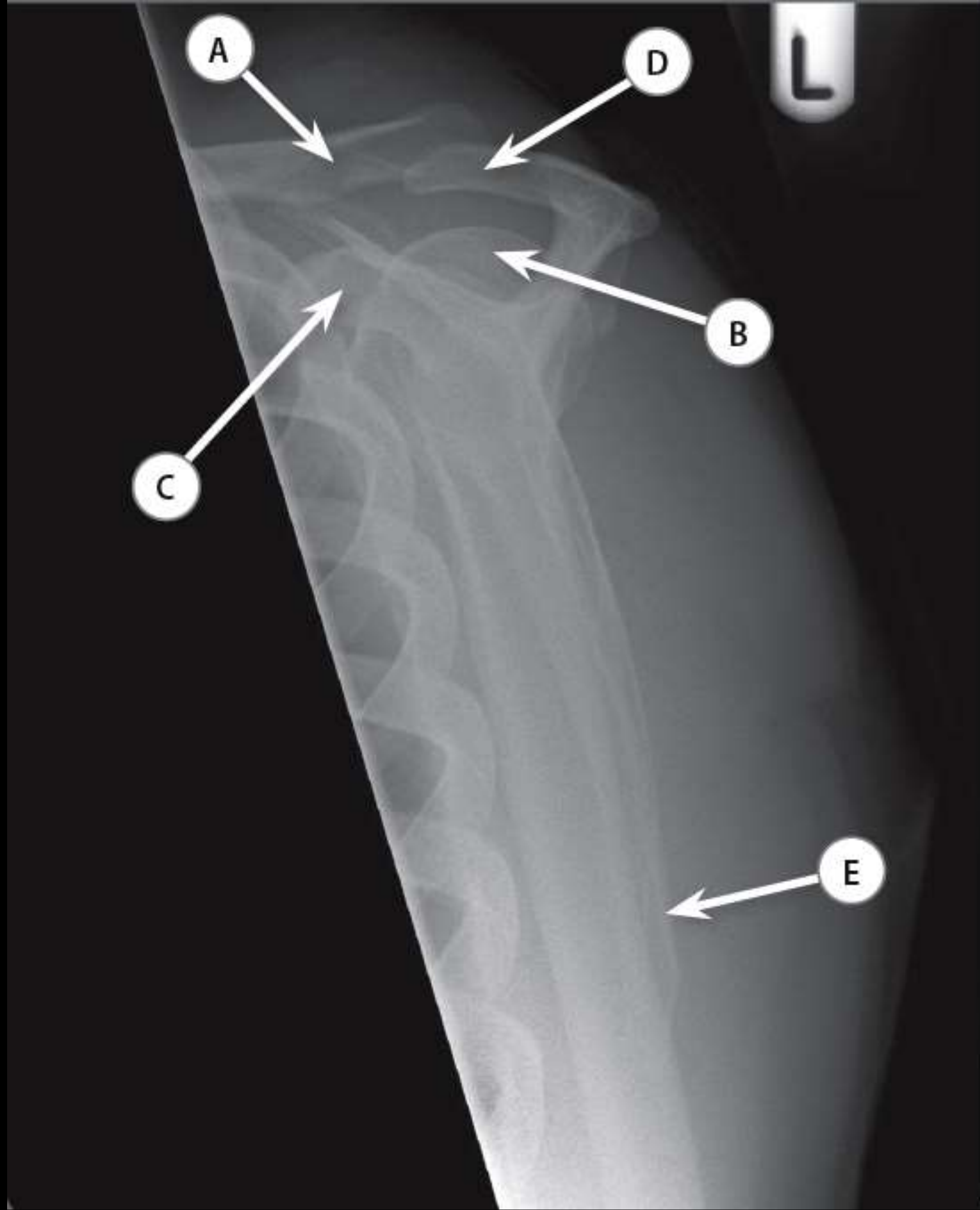
Right
12
11
15
13
14
MA
kV: 70 mAs: 16
DAP= 1.65 e(2) mGycm2

Shoulder Radiograph

11. Right acromion process
12. Right acromioclavicular joint
13. Right glenoid
14. Right shaft of humerus
15. Right coracoid process

In case of fixed bony landmarks, it is important to recognise either the anterior or posterior most structure and work out the other parts of the scapula. On the Y view, the coracoid process is the anterior structure and closest to the ribs.

Case 5.2



Case 5.2

A Distal left clavicle

B Head of left humerus

C Coracoid process of left scapula

D Acromion of left scapula

E Blade of left scapula

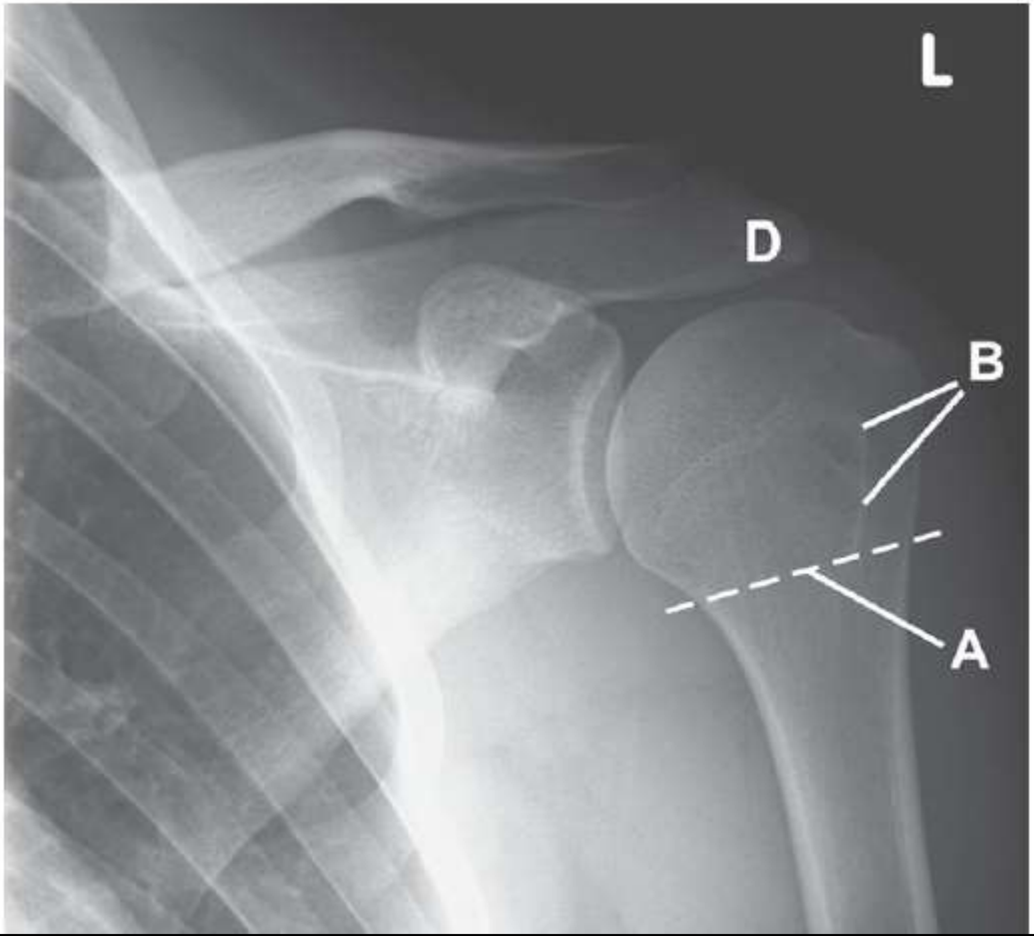
The lateral scapular view, also known as the 'Y' view, may be difficult to interpret. However, orientating yourself with simple landmarks will allow you to easily put all the pieces of the puzzle together.

Key landmarks:

- The distal clavicle articulates with the acromion at the acromioclavicular (AC) joint
- The coracoid process points anteriorly (hence the humeral head is visualised beneath the coracoid in an anterior glenohumeral dislocation)
- The spine of the scapula is a horizontal bony boundary between the supraspinatus and infraspinatus muscles.

Q1

a Name the structure labelled A
b Name the structure labelled B
c Name the structure that runs immediately lateral to the structure labelled B
d Name the structure labelled D
e Name the structures that connect the underside of the clavicle to the coracoid process



Q1 Answers

a Surgical neck of humerus
b Lesser tubercle of humerus
c Tendon of long head of biceps brachii
d Acromion process of scapula
e Trapezoid and conoid components of the coracoclavicular ligament

Radiograph of shoulder, AP view

The humerus has both anatomical and surgical necks. The anatomical neck defines the border of the articular surface which covers approximately half of the humeral head. The surgical neck is where the humeral head meets the shaft; fractures commonly occur at the surgical neck, hence the name.

Laterally, the humeral head has a greater and lesser tubercle. The tubercles are raised areas which allow for muscular attachment; the rotator cuff muscles attach to the tubercles of the humerus. Between the greater and lesser tubercles runs the inter-tubercular groove. The tendon of the long head of biceps runs through this groove before attaching to the superior lip of the glenoid within the joint capsule of the shoulder.

As well as the acromioclavicular joint (ACJ), the clavicle and scapula are linked via the coracoclavicular ligament which is made up of a laterally situated trapezoid ligament and the more medial conoid ligament. In cases of ACJ rupture the union between these two bones remains stable if the coracoclavicular ligaments are intact.

Q2

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the structure that lies at the centre of the 'Y' labelled as E

Q2 Answers

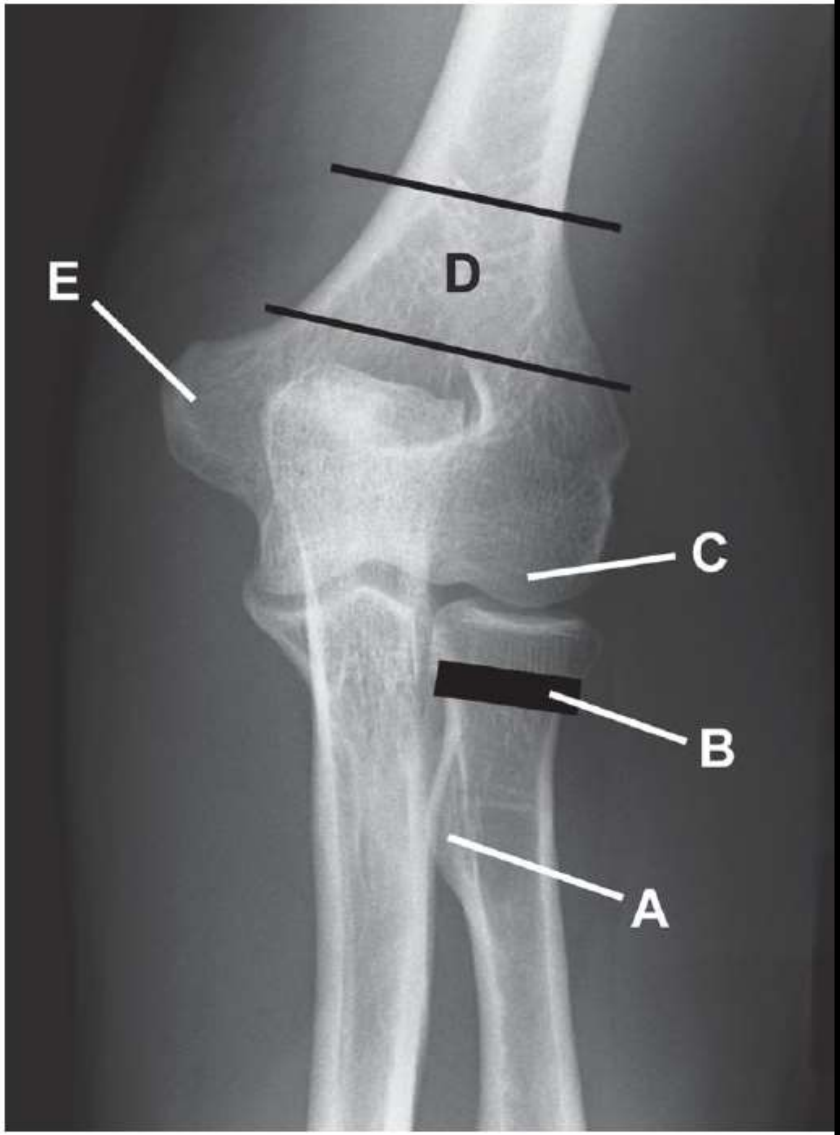
- **a** Clavicle
- **b** Acromio-clavicular joint space
- **c** Coracoid process
- **d** Spine of the scapula
- **e** Glenoid cavity

Trans-scapular radiograph of the shoulder

The trans-scapular view of the shoulder is predominantly used to determine whether the humeral head articulates normally with the glenoid. The glenoid is identified as the point where the coracoid process, body and spine of the scapula meet; the humeral head should be projected centrally over this area. For further orientation, the coracoid process faces anteriorly (to the left of the image provided here).

Q10

a Name the structure labelled A
b Name the soft tissue structure represented here in black and labelled B which allows rotation of the proximal radius on the neighbouring ulna
c Name the structure labelled C
d Name the flared part of the humerus labelled D
e Name the function of the major muscle group that attaches to E



Q10 Answers

a Radial tuberosity
b Annular ligament
c Capitulum
d Metaphysis
e Flexor muscles of the forearm

Radiograph of a skeletally mature elbow, AP view

The tendon for biceps brachii attaches to the radial tuberosity. There is also a bicipital aponeurosis which attaches more medially to the fascia of the forearm.

The annular ligament forms a collar around the head of the radius allowing radial rotation, a movement performed during pronation and supination of the forearm. Knowledge of the annular ligament is important as the radial head can be subluxed from this attachment in cases of 'pulled elbow' in children.

The capitulum of the humerus articulates with the radial head (the prefix *capit* indicates head).

The flared part of any long bone adjacent to the epiphyseal plate is known as the metaphysis.

Forearm flexors attach to the medial epicondyle (the common flexor origin – the site of pain in 'golfers elbow') while forearm extensors attach to the lateral epicondyle (the common extensor origin – the site of pain in 'tennis elbow').


A
E
B
C
D

Q11 Answers

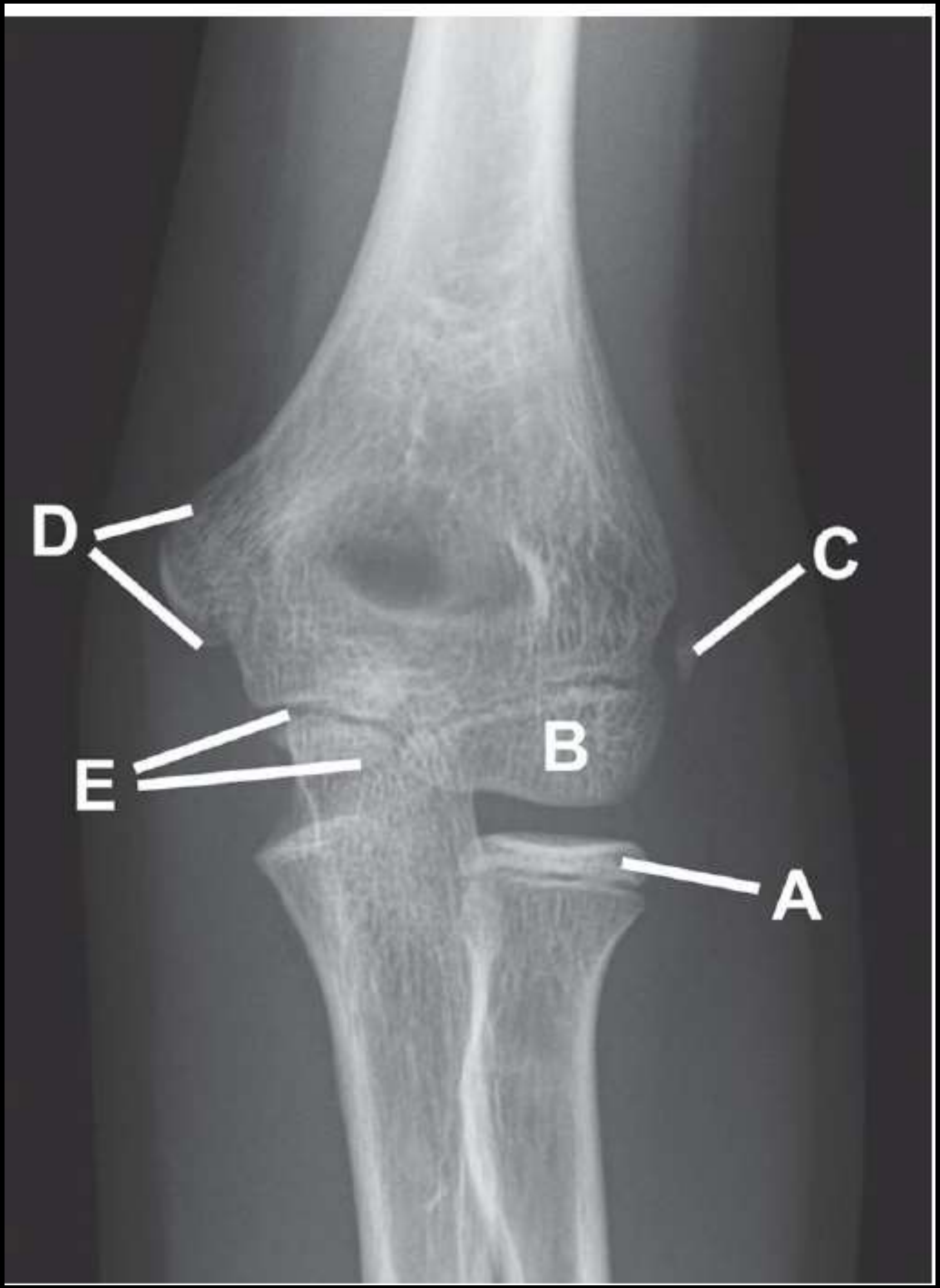
a Anterior fat pad
b Olecranon fossa
c Anterior humeral line
d Olecranon process
e Coronoid process of ulna

Radiograph of a skeletally mature elbow, lateral view

The anterior fat pad (intracapsular, extrasynovial) is normally visible on a true lateral radiograph of the elbow. There is also a posterior elbow fat pad which normally resides in the olecranon fossa and is therefore not usually visible. An elbow effusion of any cause can raise the posterior fat pad out of the olecranon fossa making it visible on a lateral radiograph, i.e. the *posterior fat pad sign*.

The olecranon fossa is a recess on the posterior aspect of the distal humerus which allows space for the olecranon process of the ulna when the elbow is fully extended.

If a line is drawn down the anterior aspect of the humerus on a lateral elbow view, this line should bisect the anterior third of the trochlea. Supracondylar fractures of the humerus can disrupt this normal alignment.

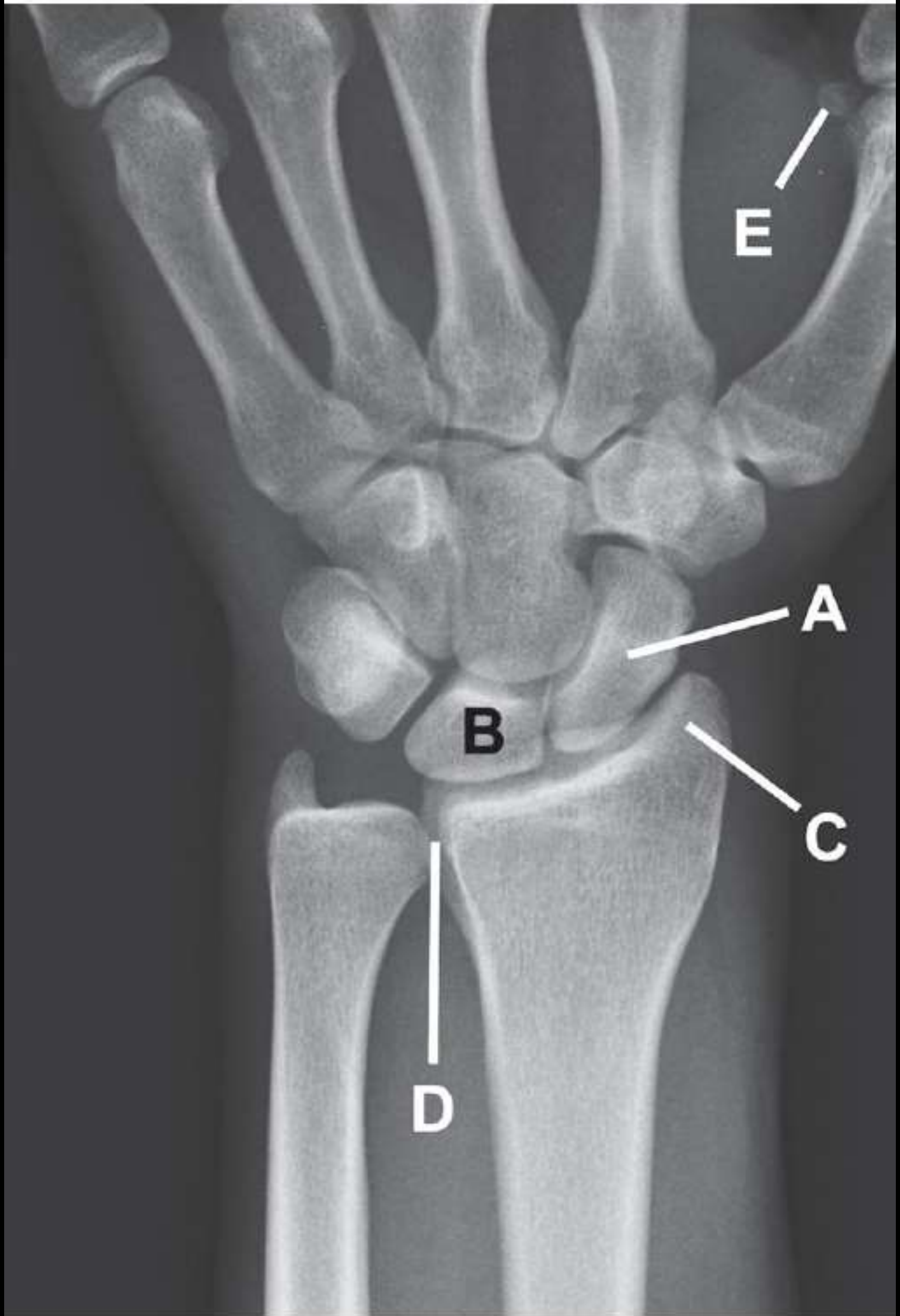

D
C
B
E
A

Q12 Answers

a Epiphysis of radial head
b Epiphysis of capitulum
c Epiphysis of lateral epicondyle
d Epiphysis of medial epicondyle
e Epiphysis of trochlea

Radiograph of elbow in a 12 year-old child, AP view

Skeletal development at the elbow involves six epiphyses. These growth centres ossify in a consistent order although the age for the appearance of each centre can vary between individuals. It is important to remember the order in which these growth centres appear on plain radiography so that all bony fragments can be accounted for and none are missed. The medial and lateral epicondylar epiphyses in particular, are prone to injury and can appear in abnormal positions following trauma. The order in which these bony growth centres appear is remembered by the acronym CRITOE: The capitulum (C) appears first, usually around one year of age. Next is the radial head (R), and then the medial or internal (I) epicondyle; these are seen around five years of age. The trochlea (T) is seen around 11 years, closely followed by the olecranon (O) at 12 years. Finally, the lateral or external (E) epicondyle is usually apparent by 13 years of age.


E
A
B
C
D

Q15 Answers

a Scaphoid
b Lunate
c Radial styloid process
d Distal radioulnar joint
e Sesamoid bone on the thumb

Radiograph of the distal forearm and wrist, AP view

The eight carpal bones lie in two rows of four. The proximal row contains, from lateral to medial, the scaphoid, lunate, triquetrum and pisiform. With the exceptio of the pisiform these bones form a semicircle, the convexity of which is proximal and articulates with the corresponding concave surface of the radius. The distal ro is formed, again from lateral to medial, by the trapezium, trapezoid, capitate and hamate; these bones articulate with the proximal row at the mid-carpal joint. The bones within each row articulate at intercarpal joints.

The ulnar surface of the distal radius has a notch for articulation with the ulna – the distal radioulnar joint. Holding the radius and ulna together at the distal radioulnar joint is the triangular cartilage running from the medial surface of the radius to the styloid process of the ulna. Situated laterally is the pyramidal radial styloid process.

In the thumb, a pair of sesamoid bones articulate with the flexor surface of the metacarpal head. They are contained within the tendons of flexor pollicis brevis and adductor pollicis.

Q16

a Name the structure labelled A
b Name the soft tissue structure which articulates the distal ulna with the carpus and is located in the position labelled B
c Name the carpal bone labelled C
d Name the space indicated by D
e Name the carpal bone labelled E

Q16 Answers

a Ulna styloid
b Triangular fibrocartilage
c Pisiform
d Scapho-lunate joint space
e Trapezoid

Radiograph of right carpus, oblique view

The distal ulna appears shorter than the adjacent radius at the wrist on plain radiographs. What is not apparent on these images is the existence of the triangular fibrocartilage; this intracapsular structure articulates with the distal ulna and with the triquetral and lunate carpal bones. The triangular fibrocartilage can be visualized on MRI and arthrography can better demonstrate its integrity; if disrupted, intracapsular contrast can spill into the distal radio-ulnar joint.

With an AP view of the wrist, the scaphoid and lunate normally overlap slightly. On this oblique view the joint space is however, visible.


D
C
A
B
L
E

Q17 Answers

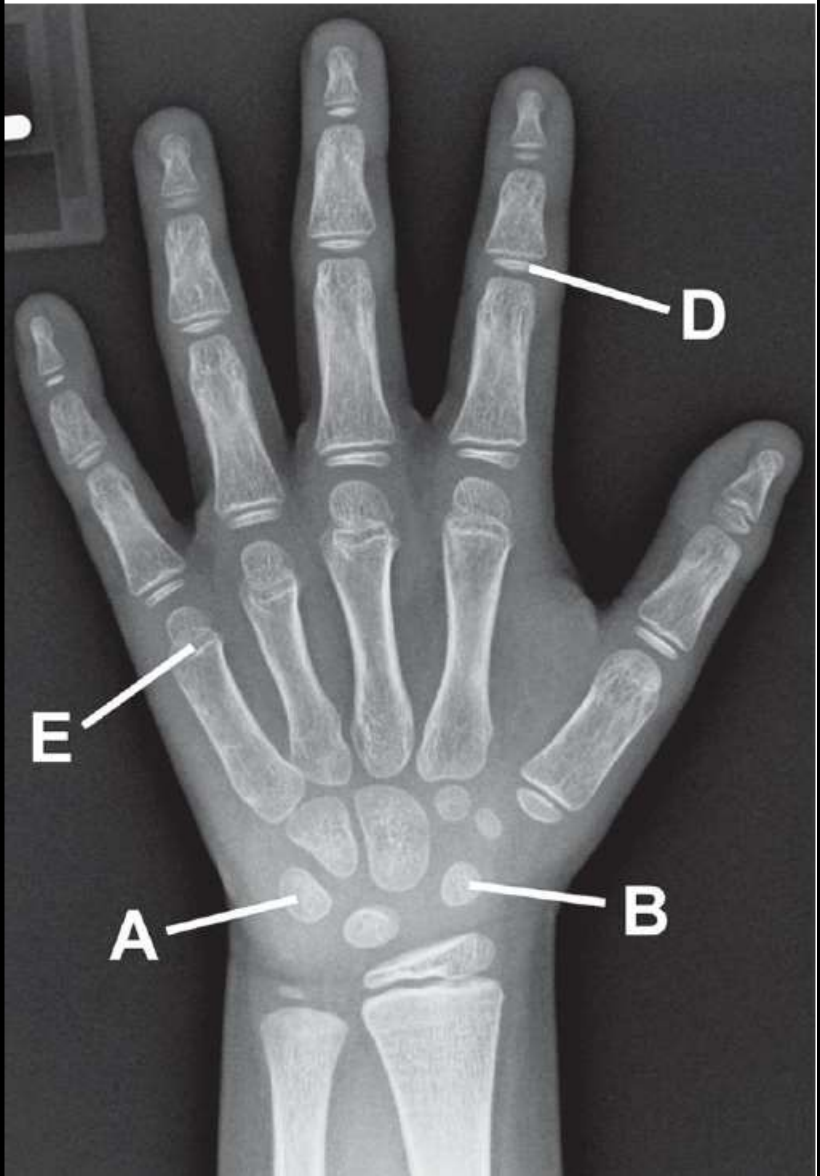
a Capitate
b Lunate
c Scaphoid
d Trapezium
e Ulna

Radiograph of wrist, lateral view

When viewed laterally, the lunate normally rests within the cup-shaped distal end of the radius. Similarly, the capitate sits within the distal hollow formed by the curve of the lunate; i.e. capitate sits within lunate sits within radius. This configuration is disrupted in lunate and perilunate dislocations which are best demonstrated with the lateral view. The other carpal bones are more difficult to recognize when viewed laterally as there is too much overlap, however by remembering that *the trapezium sits under the thumb*, this bone can also be identified. Due to differences in the appearance of their styloid processes, the radius and ulna can also usually be differentiated.

Q19

a Name the structure labelled A
b Name the structure labelled B
c Define the age by which ossification has begun in all eight of the carpal bones
d Name the structure labelled D
e Name the structure labelled E



Q19 Answers

a Triquetral
b Scaphoid
c 12 years
d Epiphysis for the middle phalynx of the index finger
e Physis for the 5th metacarpal

Radiograph of the hand and wrist in a 7 year-old child, AP view

There are multiple ossification centres in the developing hand and wrist. The carpal bones ossify in a predictable fashion; the capitate and hamate are visible by one year of age, the triquetral by two years, the lunate by three years, the scaphoid, trapezoid and trapezium appear by six years of age while the pisiform is expected by the age of 12 years. A child's physiological age can be estimated by comparing the extent of bony development against published radiographic standards of normal. In such calculations, the epiphyses of the metacarpals and digits are often assessed, it is therefore important to know where each epiphysis belongs in relation to its parent bone. The metacarpal epiphyses lie distal to the bone (this can be confused with or mask a common injury to the 5th metacarpal), while the phalangeal epiphyses lie proximally.

Case 4.32

Case 4.32

A Left lunate

B Left hamate

C Left ulnar styloid

D Proximal phalanx of the left index finger

E Metacarpophalangeal joint of the left ring finger

Dorsopalmar radiograph of the left hand.

The two rows of carpal bones form an arch with its concavity anteriorly, allowing the carpal tunnel to be formed with the flexor retinaculum forming its roof. The carpal bones from lateral to medial consist of:

- **Proximal**: scaphoid, lunate, triquetral and pisiform lying anterior to triquetral.
- **Distal**: trapezium, trapezoid, capitate and hamate.

The ulnar styloid is narrower and more proximal than the radial styloid.

It is convention to name the metacarpals and phalanges rather than number them to avoid confusion.

The third metacarpal has a styloid at the base of the dorsal aspect.

There are two normal variants you must be aware of in the hand:

- The **os centrale** – found between the scaphoid, trapezoid and capitate. It may represent the unfused tubercle of the scaphoid.
- The **os radiale externum** – found on the radial side of the scaphoid distal to the radial styloid.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 74–75.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 255.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 344–345.

Case 4.33

Case 4.33

A Right capitate

B Right lunate

C Right pisiform

D Right scaphoid

E Right 1st metacarpal

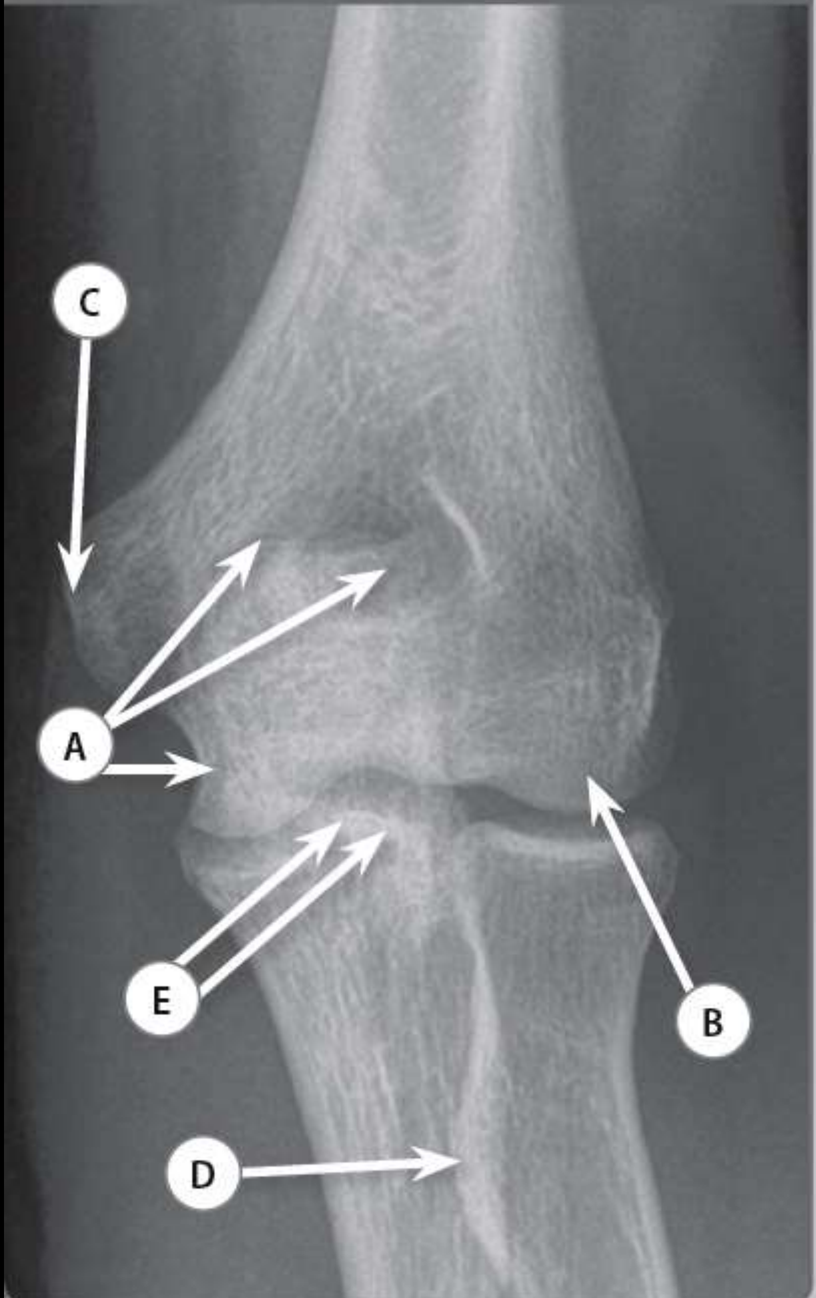
Lateral radiograph of the wrist.

The lunate is the key bone to understand this projection. The proximal surface of the lunate is convex and articulates with the distal radius. The distal surface of the lunate is concave and articulates with the capitate.

In a true lateral radiograph of the wrist, the most palmar carpal bone cortex belongs to the scaphoid. The palmar cortex of the pisiform lies between the palmar cortex of the scaphoid and the palmar cortex of the capitate.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 74.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 271.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 344–345.

Case 4.34



Case 4.34

A Olecranon of the left ulna

B Capitellum of the left humerus

C Medial epicondyle of the left humerus

D Left radial tuberosity

E Coronoid process of the left ulna

Anteroposterior radiograph of the right elbow.

The distal humerus has articular surfaces for the radial head and olecranon fossa of the ulna. These are called the capitellum (interchangeable with capitulum) and trochlea respectively. Two other features of the distal humerus are the coronoid fossa and the olecranon fossa. The coronoid fossa lies anterior and superior to the trochlea, and the olecranon fossa lies posteriorly.

The radial head is cylindrical and sits on a narrower radial neck. The radial tuberosity is medial and is the point of attachment for the biceps brachii.

The olecranon of the ulna is hook shaped with a concavity, the trochlear fossa. The olecranon is the point of attachment for the triceps muscle.

The coronoid process is the point of attachment for brachialis, the wrist flexors, and pronator teres.

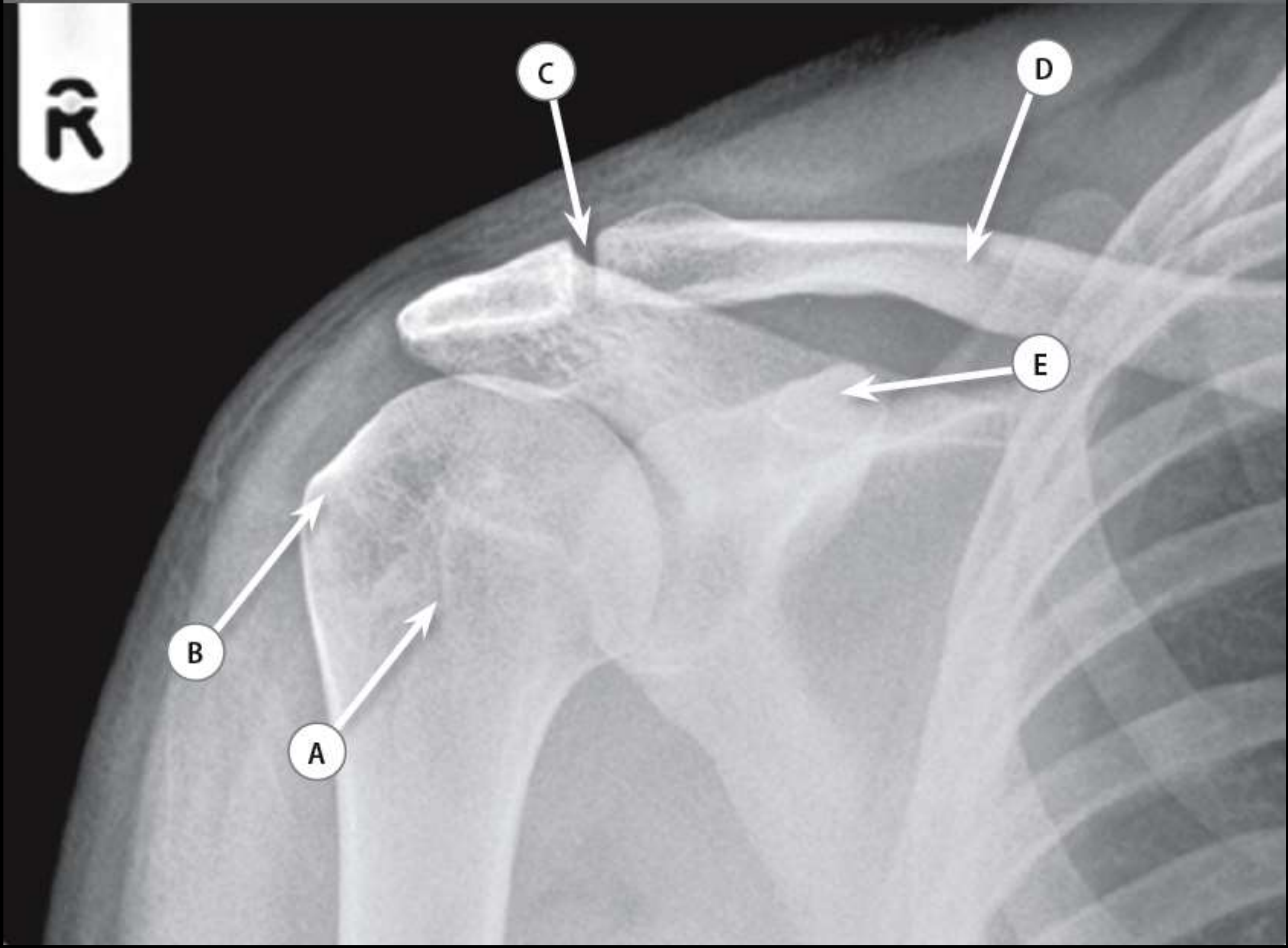
If you are given a paediatric film, you may be asked the age at which one of the secondary centres of ossification appears. The mnemonic to use is CRITOL:

- Capitellum: 1 year
- Radial head: 5 years
- Internal epicondyle: 5 years
- Trochlea: 11 years
- Olecranon: 12 years
- Lateral epicondyle: 13 years

These figures vary slightly between textbooks. Fusion occurs in late teenage years.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 71–72.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 254.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 341–342.

Case 4.39



Case 4.39

A Surgical neck of the right humerus

B Greater tuberosity of the right humerus

C Right acromioclavicular joint

D Right clavicle

E Coracoid process of the right scapula

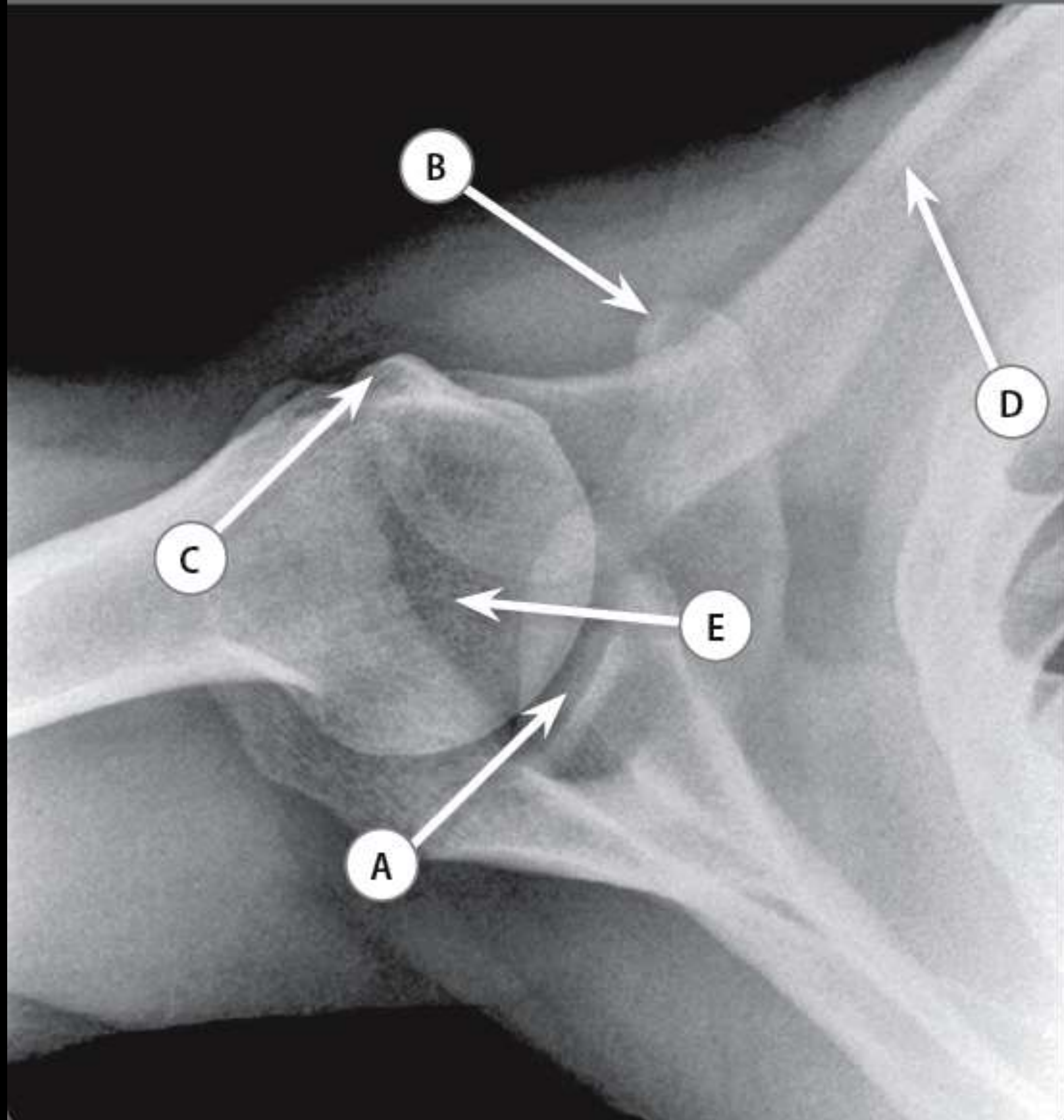
Anteroposterior radiograph of right shoulder.

The head of the humerus is hemispherical and it articulates with the glenoid fossa of the scapula. The anatomical neck of the humerus is formed by the boundary of the joint capsule. It separates the head of the humerus from the greater and lesser tuberosity. Note the position of the greater and lesser tuberosity on this projection and compare it with the axial projection. Between the tuberosities lies the bicipital groove for the long head of biceps.

The part of the shaft just below the tuberosities is called the surgical neck due to the tendency of the humerus to fracture at this point.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 68–69.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 334.

Case 4.40



Case 4.40

A Glenoid fossa of the left scapula

B Coracoid process of the left scapula

C Lesser tuberosity of the left humerus

D Left clavicle

E Head of the left humerus

Axial radiograph of the shoulder.

Two articulations are visible on this radiograph: the glenohumeral joint and the acromioclavicular joint. Note the appearance of the humeral tubercles and the coracoid process. This is a good example of an image where wrongly identifying one structure will lead to wrongly identifying the rest. The key to identifying the structures on a shoulder radiograph is to identify which projection is given. It is important to appreciate the relations of the bony landmarks on different projections. A good starting point is to identify the coracoid process which points anteriorly.

The standard plain radiographic views of the shoulder are the anteroposterior and axial projections. The other important projections are the transscapular view (y-view) and Striker's view, which is acquired with the beam angled through the axilla to provide anatomical detail of the posterior aspect of the humeral head.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 68.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 252.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 336.

- **Question 3:**

Question 3: Lateral radiograph of the left elbow

Answer: Olecranon process of ulna

- The proximal ulna articulates with the humerus via a hooklike projection with two curved eminences.
- The curved posterior eminence is the olecranon, which fits into the olecranon fossa of the humerus and articulates with the trochlea of the humerus.
- Make sure that you are able to distinguish between the olecranon and the coronoid process, which is the volar eminence of the proximal ulna.
- The triceps brachii muscle inserts onto the olecranon process.

- **Question 26:**

■ Question 26: AP radiograph of the forearm

Answer: Right little finger metacarpal

- Each metacarpal bone can be divided into three parts: head, body, and base.

- **Question 27:**

Question 27: Plain radiograph of the wrist

Answer: Scaphoid bone

- The scaphoid bone has a boatlike configuration and can be divided into the proximal pole and distal pole with the waist in between.
- It is the largest of the proximal carpal row bones.
- It articulates proximally with the radius, lunate, capitate, trapezoid, and trapezium.
- It is perfused in a retrograde fashion by a single branch from the radial artery.

■ Question 35:

Question 35: AP radiograph of the left hand

Answer: Epiphysis of the left thumb metacarpal

- The epiphysis of the thumb metacarpal is at the base of the metacarpal diaphysis.
- This differs from the epiphyses of the other metacarpals, where it is situated distal to the metacarpal diaphysis.

■ Question 38:

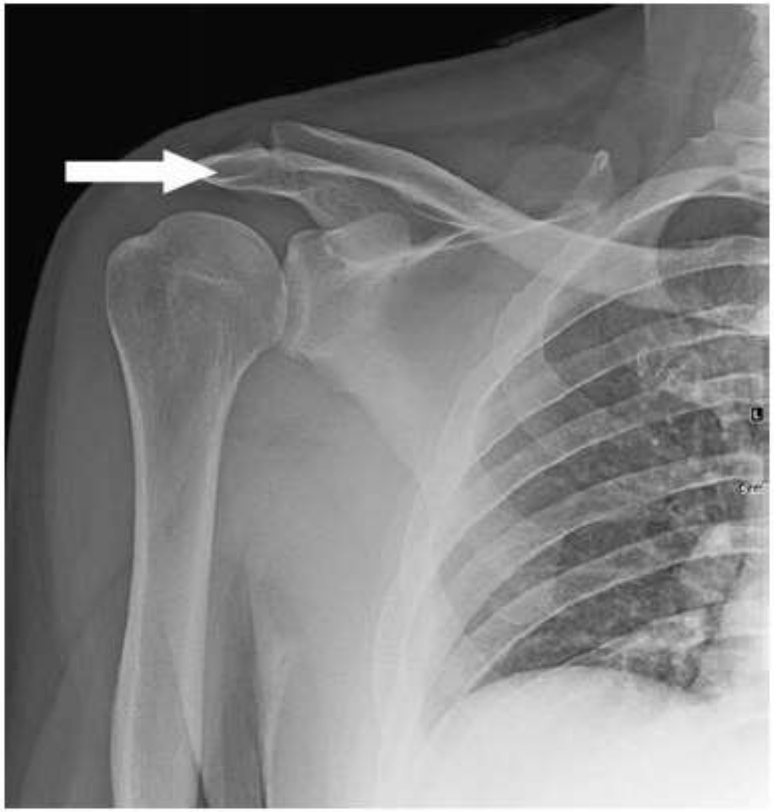
Question 38: AP radiograph of the left elbow

Answer: Ossification centre of the left internal (medial) epicondyle

- Knowing when the different ossification centres appear is essential for this question.
- The acronym CRITOL can be used:

C	Capitulum (or capitellum)	1 year
R	Radial head	3 years
I	Internal epicondyle	5 years
T	Trochlear	10 years
O	Olecranon	10 years
L	Lateral epicondyle	11 years

- **Question 44:**

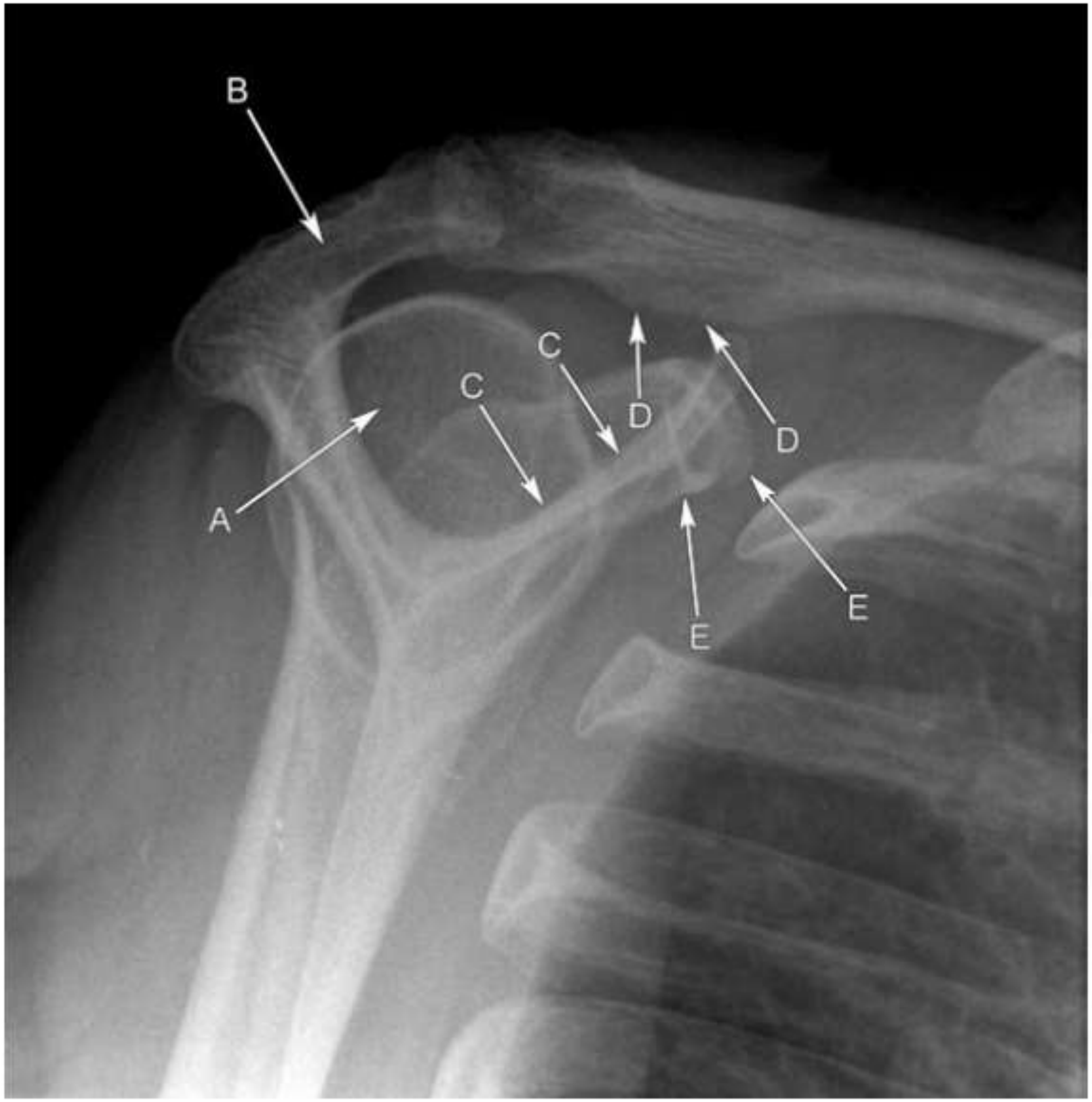


Question 44: Plain radiograph of the right shoulder

Answer: Right acromion process

- The acromion is the superolateral continuation of the scapular spine.
- It is triangular in configuration and bends anterolaterally to form the summit of the shoulder.
- It articulates with the clavicle at the acromioclavicular joint.
- The acromion has four ossification centres, which usually fuse by adulthood. Failure of one of the ossification centres to fuse will result in an os acromiale.

Question 2.16



Name the structures labelled **A** to **E**.

2.16 Y view X-ray of the right shoulder

A Right humerus head.
B Right acromion.
C Spine of the right scapula.
D Right conoid tubercle.
E Right coracoid process.

The Y view shoulder radiograph refers to the Y-shaped appearance of the scapula on this projection. The body of the scapula represents the stem of the Y. The acromion represents the posterior fork of the Y and the coracoid process represents the anterior fork of the Y. The centre of the Y is the glenoid with the humeral head projected over the centre and the shaft of the humerus projected over the stem of the Y. Anterior or posterior dislocation or subluxation can be assessed on the Y view by assessing the relationship of the humeral head to the glenoid.

Question 2.17

This is a radiograph of right forearm.
Name the structures labelled **A** to **E**.

2.17 AP X-ray of the paediatric right forearm

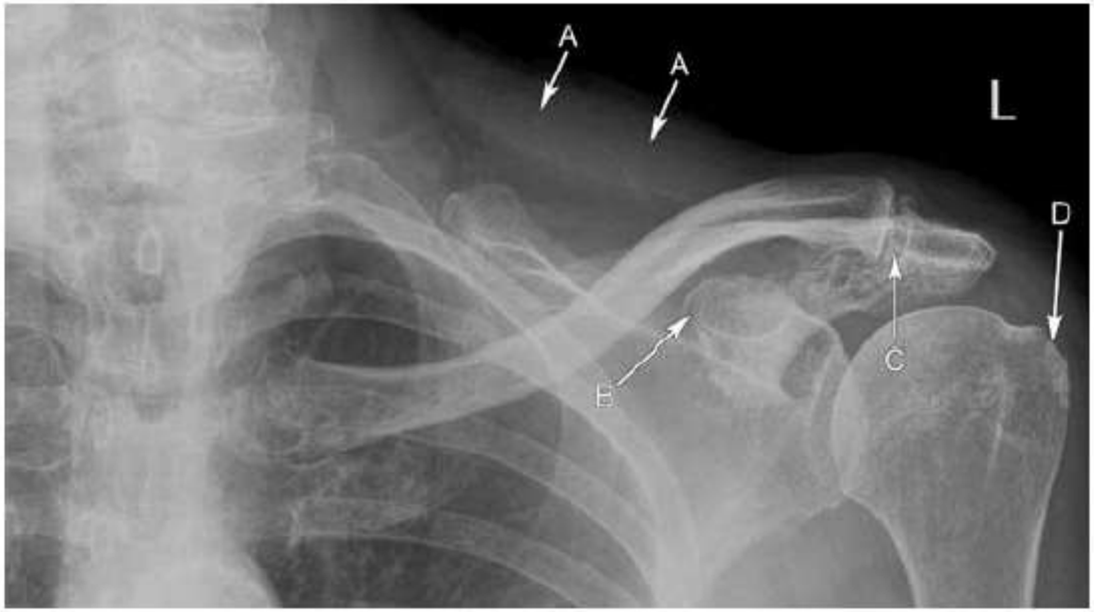
A Capitate.
B Lunate.
C Scaphoid.
D Radius.
E Ulna.

In the paediatric wrist, the epiphyseal gaps between the carpal bones and between the radius and ulna are normal and must not be confused with ligamental disruption. The gap between the carpal bones within an adult is normally less than 2 mm. Widening of this gap may indicate ligamentous disruption.

Mnemonics for remembering the carpal bones from the proximal to distal row include 'Some Lovers Try Positions That They Cannot Handle', translating as Scaphoid, Lunate, Triquetral, Pisiform, Trapezium, Trapezoid, Capitate and Hamate.

Confusion between the trapezium and the trapezoid can be cleared by remembering trapeziTHUMB, as the trapeziUM articulates with the thUMB.

Question 2.20



Name the structures labelled **A** to **D**.

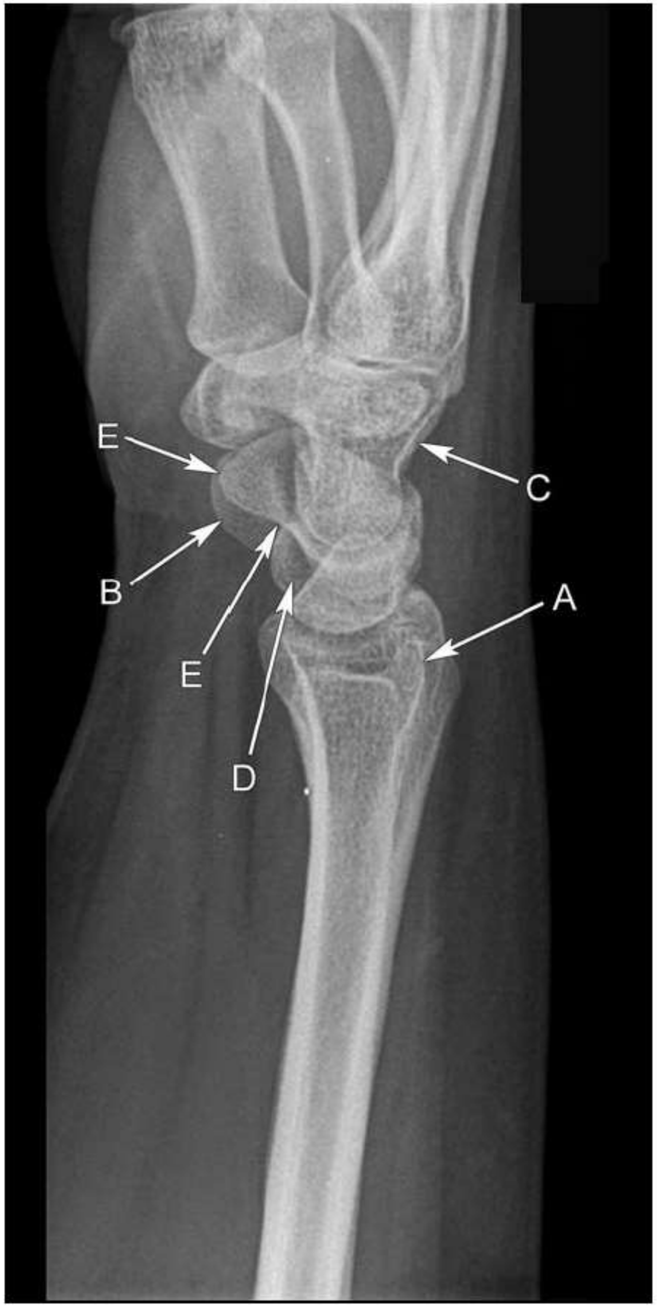
E Which three ligaments attach to B?

2.20 AP X-ray of the left clavice

A Left trapezius muscle.
B Left coracoid process.
C Left acromioclavicular joint.
D Greater tuberosity of the left humerus.
E Left coracoclavicular, coracoacromial and coracohumeral ligaments.

The AP projection of the clavicle includes the entirety of the clavicle from the medial articulation with the sternum (the sternoclavicular joint) to the lateral articulation with the acromion (the acromioclavicular joint). Many of the major muscle groups of the shoulder and anterior chest wall have attachments to the clavicle, including the deltoid, trapezius and pectoralis major. The subclavian vessels and brachial plexus pass behind the medial portion of the clavicle. The acromioclavicular joint is stabilized by acromioclavicular ligaments with further vertical stability provided by the coracoacromial and the coracoclavicular ligaments. Tears of these ligaments allow the upper limb to fall inferiorly, separating the clavicle from the acromion with subsequent acromioclavicular dislocation.

Question 4.16



Name the structures labelled **A** to **E**.

4.16 Lateral X-ray of the right wrist

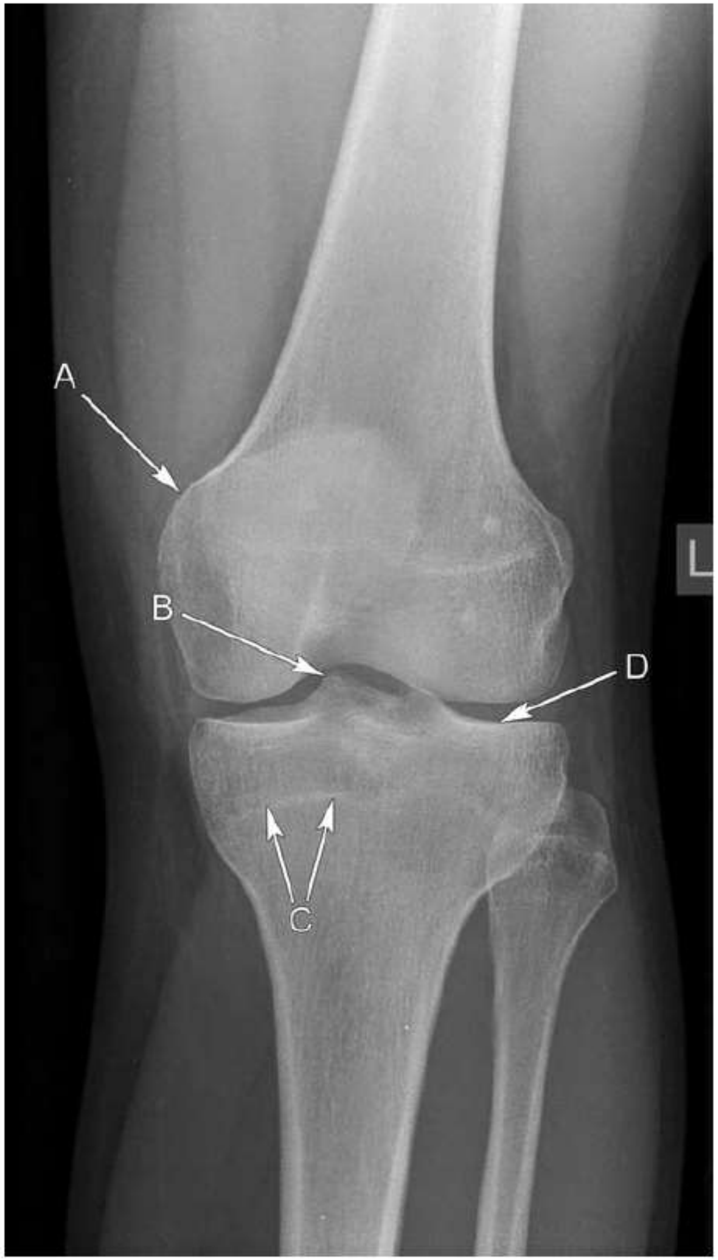
A Right ulnar styloid.
B Right pisiform.
C Right capitate.
D Right lunate.
E Right scaphoid.

Assessing the alignment of the carpal bones on a lateral X-ray is common everyday practice in radiology. Remember the 'order of the cups and cap'. The lunate sits within the cup of the radius and the capitate sits within the cup of the lunate, i.e. radius **CUP** lunate **CUP CAP**itate.

If there is loss of the alignment of this column of cups then a lunate or perilunate dislocation should be suspected. Indeed the pathognomonic sign of a lunate dislocation is the 'spilled tea cup' sign, where the 'cup' (lunate) is seen to point or 'spill' onto the palm.

When assessing the lateral wrist X-ray for trauma, it is important to assess the angle between the scaphoid and the lunate to detect scapholunate dissociation.

Question 5.9



Name the structures labelled A to D.
E What structure attaches to A?

5.9 AP X-ray of the left knee

A Left adductor tubercle.
B Left medial tibial spine.
C Left fused growth plate, proximal tibia.
D Left lateral tibial plateau.
E Left adductor magnus muscle.

A tubercle is a small protuberance of a bone. At the most superior aspect of the medial epicondyle of the femur is a small tubercle called the adductor tubercle. This is the insertion point for the adductor magnus. The tibial spine lies between the articular facets of the tibia. Fractures of the tibial spine (or the intercondylar eminence, as it otherwise known) can be subtle on radiographs of the knee and are associated with cruciate ligament injury. The area around the head of the fibula is another area that needs to be studied on trauma knee radiographs to look for the subtle Segond fracture (avulsion fracture of the lateral tibial condyle). Segond fractures have a high association with tears of the anterior cruciate ligament and injury to the medial meniscus.

Question 5.16

Name the structures labelled A to E.

5.16 AP X-ray of the right elbow (paediatric)

A Right lateral epicondyle apophysis.
B Right medial epicondyle apophysis.

C Right trochlea epiphysis.
D Right capitellum epiphysis.
E Right radial tuberosity.

The order of appearance of the elbow ossification centres can be remembered by the mnemonic **CRITOL:**

- Capitellum (six months).
- Radial head (five years).
- Internal (medial) epicondyle (seven years).
- Trochlea (nine years).
- Olecranon (eleven years).
- Lateral epicondyle (thirteen years).

The capitellum, trochlea and radial head contribute to longitudinal bone growth and make up an articular surface; they are therefore considered to be epiphyses. All of the other ossification centres of the elbow are apophyses.

Question 6.20

Name the structures labelled **A** to **D**.

E Which three muscles attach to the structure labelled **B**?

6.20 Axial X-ray of the right shoulder

A Right spine of scapula.
B Right coracoid process.
C Right clavicle.
D Right scapula blade or body.
E Pectoralis minor, coracobrachialis and biceps brachii (short head).

The word coracoid is based on the Greek 'korax', which means 'raven's beak'. The coracoid process resembles this shape and is a small beak-like structure on the lateal edge of the antero-superior part of the scapula. The pectoralis minor muscle runs from the coracoid process to between the third and fifth ribs. The coracobrachialis muscle runs from the coracoid process to the medial side of the humeral shaft. The biceps brachii muscle runs from the coracoid process (short head) and the supra-glenoid tubercle (long head) to the radial tuberosity.

Question 7.18

Name the structures labelled **A** to **E**.

7.18 AP and oblique X-rays of a paediatric hand

A Right trapezium.
B Right scaphoid.
C Right hamate.
D Right lunate.
E Right ulna styloid.

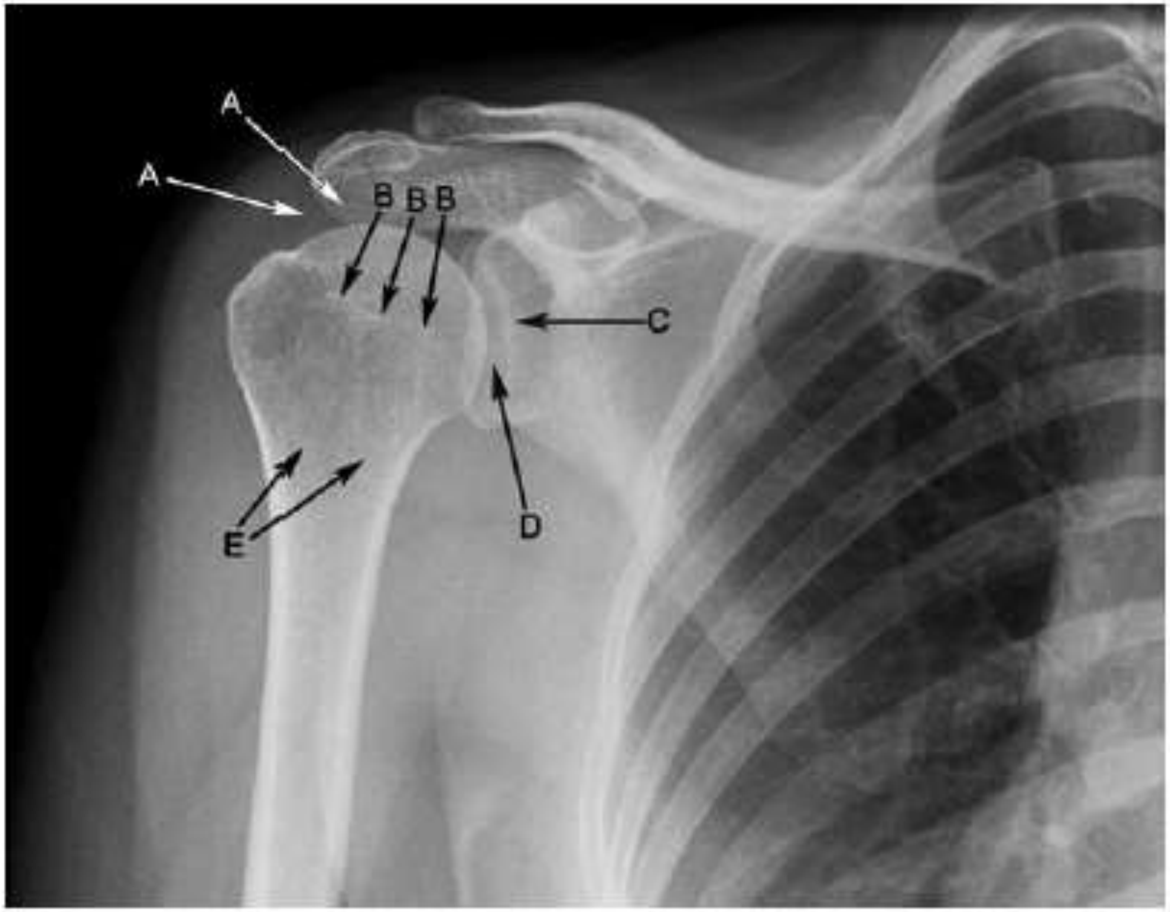
There are eight carpal bones. A useful mnemonic for remembering them is:

Sally Left The Party To Take Cathy Home.

(From radial to ulna side, proximal row to distal row: scaphoid, lunate, triquetral, pisiform, trapezium, trapezoid, capitate, hamate.)

Please see Questions 2.17, 4.16 and 9.9 for more images and explanation of the carpal bones. A table of carpal bone ossification ages can be found in the answer to Question 10.13.

Question 9.19



A What muscle is located here?
Name the structures labelled **B** to **E**.

9.19 AP X-ray of the shoulder

A Right supraspinatous muscle/tendon/subacromial joint space.
B Anatomical neck of the right humerus.
C Right glenoid.
D Right glenohumeral joint.
E Right surgical neck of the humerus.

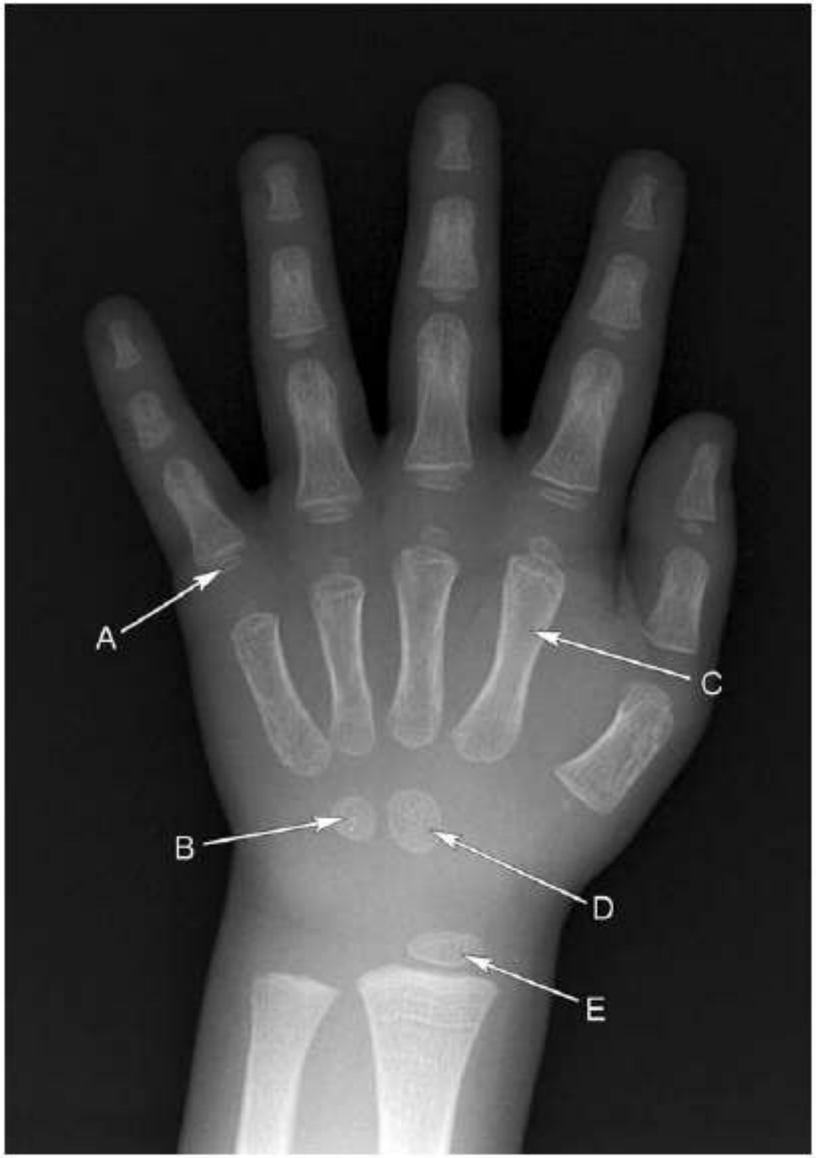
The anatomical neck of the humerus is an oblique indentation distal to the humeral head where the joint articular capsule attaches. The upper outer part of it is seen as a groove separating the head from the greater tubercle of the humerus. The surgical neck of the humerus is a narrowing of the shaft below the lesser and greater tubercle – fractures are far more common here than the anatomical neck of the humerus.

The glenohumeral joint is a multiaxial synovial ball and socket joint. The glenoid fossa itself is shallow and is reinforced by the glenoid labrum to deepen it and increase joint stability.

The supraspinatous muscle is part of the rotator cuff and acts to abduct the shoulder joint. It originates in the supraspinous fossa and its tendon passes under the acromion through the supraspinatous outlet, finally inserting onto the greater tuberosity of the humerus. The supraspinatous outlet is formed by the acromion, coracoacromial arch, acromioclavicular joint, glenoid and humeral head. Abnormality of the outlet can lead to supraspinatous impingement and rotator cuff tendonitis. The supraspinatous tendon can be examined with both ultrasound and MRI. There are also dedicated X-ray views for assessing the supraspinatous outlet:

Stryker notch view	Looks for os acromiale
Supraspinatous outlet view	Useful for measuring subacromial space (<7mm = increased risk of impingement) Good for assessing morphology of acromion

Question 10.13



Name the structures labelled **A** to **E**.

10.13 X-ray of the left hand

A Left fifth proximal phalanx epiphysis.
B Left hamate.
C Left second metacarpal.
D Left capitate.
E Left distal radial epiphysis.

This child is 18 months old. The first metacarpal differs from the other four metacarpals in that its secondary ossification centre lies at the base and not at the head. These secondary ossification centres are generally all visible by age 2.

Ossification of the carpal bones occurs in a predictable sequence:

Bone	Average age at ossification
Capitate	2–4 months
Hamate	3–6 months
Triquetral	2–3 years
Lunate	4–5 years
Trapezium	6 years
Trapezoid	6–7 years
Scaphoid	6–7 years
Pisiform	11–12 years

Case 1.20

Case 1.20

QUESTION		WRITE YOUR ANSWER HERE
A	Name the ossification centre labelled A.	
B	Name the ossification centre labelled B.	
C	Name the ossification centre labelled C.	
D	Name the ossification centre labelled D.	
E	Name the ossification centre labelled E.	

Case 1.20

A Olecranon

B Medial epicondyle

C Trochlea

D Radial head

E Capitulum

In a patient of this age (9 years old), typically the only ossification centre not yet visible is the lateral epicondyle (usually visible at approximately 11 years of age). The olecranon is usually more readily identifiable on the lateral radiograph but can be clearly seen here. The mnemonic **CRITOL** can be used to help remember the order in which different ossification centres become visible, which can be very important in the context of trauma. The order is usually **C**apitulum (approximately 1 year of age), **R**adial head (3 years of age), **I**nternal (medial) epicondyle (5 years of age), **T**rochlea (7 years of age), **O**lecranon (9 years of age) and **L**ateral epicondyle (11 years of age). The numerical sequence 1 – 3 – 5 – 7 – 9 – 11 is a useful approximation of the age at which each centre begins to ossify.

Case 3.1

Case 3.1

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 3.1

A Base of the right fourth metacarpal (ring finger)

B Hook of right hamate

C Ossification centre of the proximal phalanx of right little finger

D Styloid process of right ulna

E Right pisiform

Carpal bone anatomy is essential core knowledge. Although the full bony carpus is not demonstrated on this radiograph, you should be able to orientate yourself by:

- the hamate and pisiform being on the ulnar aspect of the wrist
- the fifth digit having three phalanges
- the first digit (thumb) having only two phalanges.

Case 4.1

Case 4.1

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 4.1

A Right trapezoid

B Right hook of hamate

C Right capitate

D Styloid process of right ulna

E Distal right radio-ulnar joint

The eight carpal bones form the proximal and distal carpal rows of the wrist and include: the scaphoid, lunate, triquetral, pisiform, trapezium, trapezoid, capitate and hamate.

An easy mnemonic to remember: Scared Lovers Try Positions That They Cannot Handle.

The scaphoid articulates with the radius and is therefore a lateral structure.

The trapezium rhymes with thumb ('the thumb swings on trapezium') allowing easy differentiation from the adjacent trapezoid.

The medially situated hamate can be easily identified due to its characteristic 'Hook'.

Case 4.14

Case 4.14

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Which ossification centre is normally the next to develop?	

Case 4.14

- **A** Right radial head ossification centre
- **B** Right capitulum ossification centre
- **C** Right olecranon fossa
- **D** Right medial epicondyle ossification centre
- **E** Right trochlea ossification centre

Knowledge of the various ossification centres around the elbow joint is important in the assessment of paediatric upper limb trauma.

The mnemonic CRITOL (1-3-5-7-9-11) can be used to remember the order in which ossification centres usually appear: Capitulum (approximately 1 year of age); Radial head (approximately 3 years of age and seen here as a tiny calcific density); Internal (medial) epicondyle (5 years of age); Trochlea (7 years of age); Olecranon (9 years of age and more readily appreciated on a lateral view); and Lateral epicondyle (11 years of age). Fusion is normally complete by the age of 17.

Case 6.16

Case 6.16

A Ossification centre of the right capitulum

B Metaphysis of the base of the proximal phalanx of the little (fifth) finger

C Ossification centre of the distal right radius

D Right capitate

E Ossification centre of the right thumb metacarpal

The presence of ossification centres on paediatric radiographs will allow an estimation of a child's age. Familiarise yourself with common milestones, most importantly the elbow.

Appearances of the ossification centres of the elbow = CRITOL, 1-3-5-7-9-11 is an easy way to remember the approximate dates of ossification:

C – Capitulum (1 year)

R – Radial head (3 years)

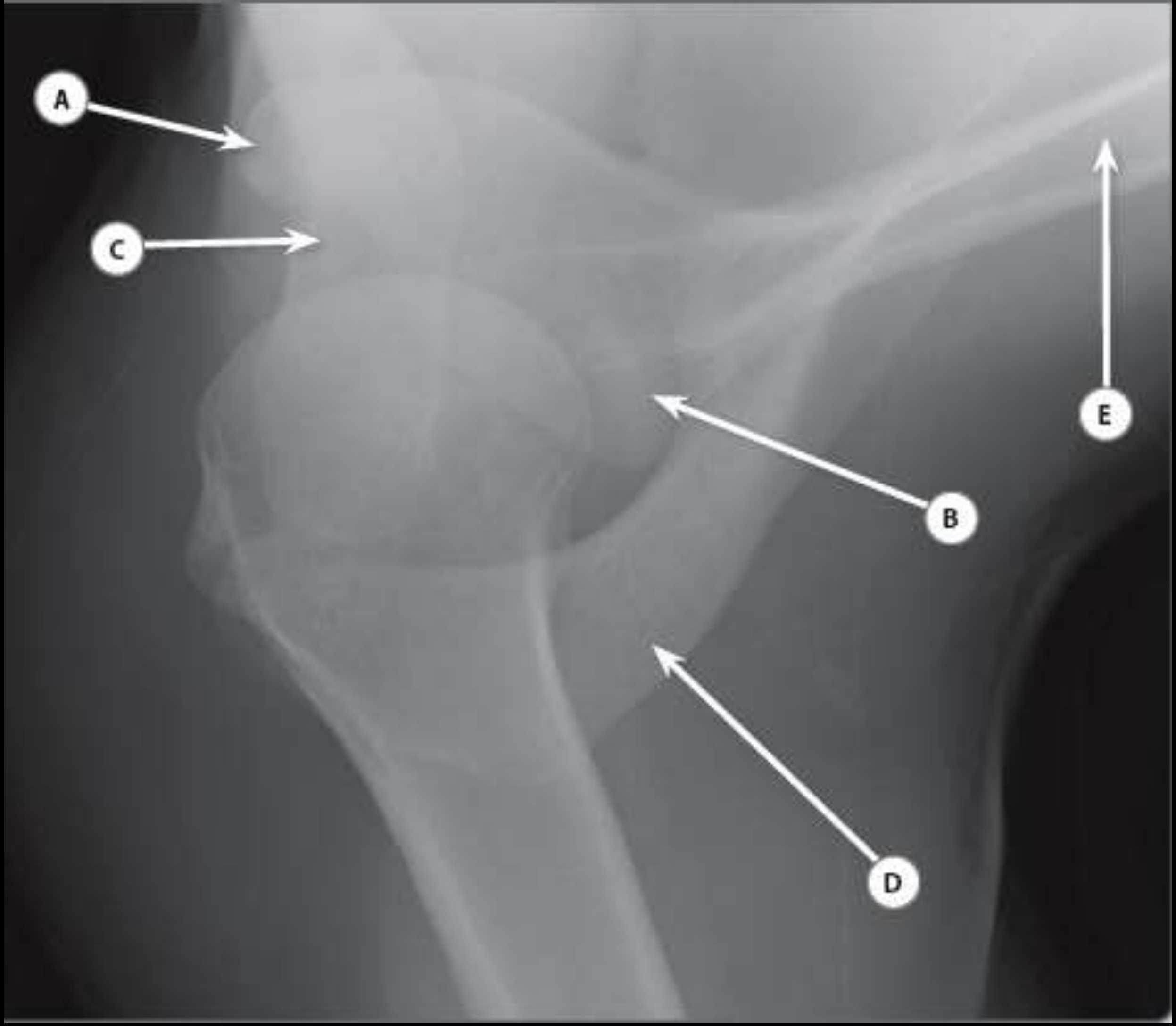
I – Medial (internal) epicondyle (5 years)

T – Trochlea (7 years)

O – Olecranon (9 years)

L – Lateral epicondyle (11 years.)

Case 7.8



Case 7.8

A Coracoid process

B Glenoid of scapula

C Clavicle (lateral part)

D Acromion

E Body of scapula

Osseous anatomy of the shoulder is fundamental knowledge for the examination. Several radiographic projections of the shoulder may be acquired (this is an axial view) – the following are a few tips to help orientate you if presented with an unusual projection:

1. The coracoid process always 'points' anteriorly
2. The acromion articulates with the clavicle at the acromioclavicular joint
3. The head of humerus articulates with the glenoid of scapula at the glenohumeral joint

Remember, the coracoid process does not articulate with an osseous structure distally. This will allow you to easily differentiate between the coracoid and acromion.

Case 8.1

Case 8.1

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the tendon that attaches to the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 8.1

A Base of the metacarpal of the thumb

B Capitulum of humerus

C Biceps brachii muscle

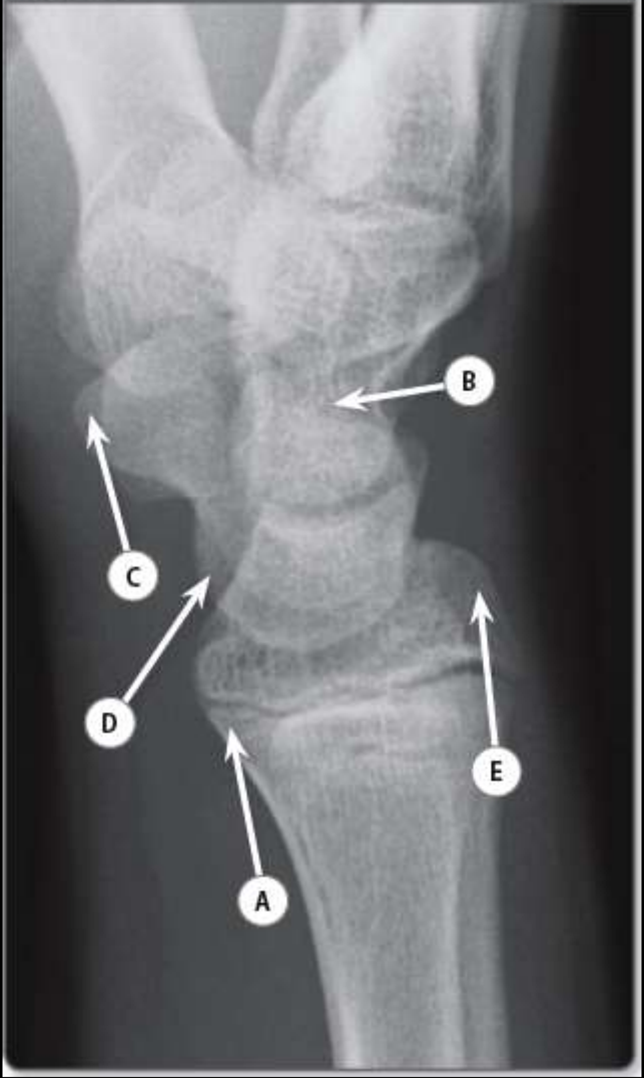
D Pisiform

E Coronoid process of ulna

There is lots of osseous anatomy on this single radiograph and the following step-by-step technique should be utilised during the examination as a fail-safe measure to answer everything correctly:

- It is clear that (A) is the base of a metacarpal but knowing the following point will allow you to confidently answer that it is the metacarpal of the thumb:
  - it is seen on the radial aspect of radiograph
  - the radius is laterally positioned
- the distal humerus articulates with both the radius and ulna
  - the capitulum (B) articulates with the head of radius
  - the trochlea articulates with the proximal ulna
- the sesamoid pisiform bone (D) is located on the ulnar aspect of the proximal carpal row and only articulates with the triquetral
- the coronoid process of the ulna (E) is shown as a triangular projection filling the groove within the trochlea of the distal humerus.

Case 9.1



Case 9.1

A Anterior corner of the distal metaphysis of the radius

B Capitate

C Distal pole of the scaphoid

D Lunate

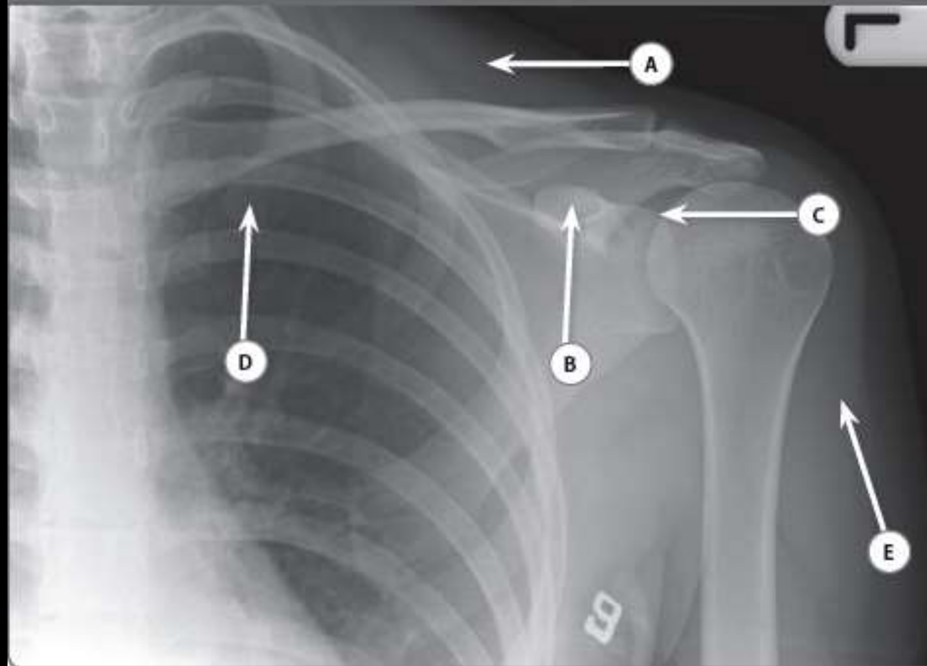
E Epiphysis of distal radius

An important feature to appreciate on the lateral radiograph of the wrist is the contiguity of the distal radius, lunate, capitate and third metacarpal, which should lie in a straight line.

If the lunate is disrupted from the line, the diagnosis of a lunate dislocation should be made.

If the radiolunate line is preserved but the line no longer passes through the capitate, a perilunate dislocation is likely.

Case 9.11



Case 9.11

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the muscle that inserts into the structure labelled B.	
C	Name the muscle that originates from the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 9.11

A Left trapezius muscle

B Left pectoralis minor muscle

C Left long head of biceps brachii muscle

D Left anterior first rib

E Left deltoid muscle

It is important to differentiate the origin and insertion of muscles, which is key to answering (B) and (C) correctly.

The coracoid process serves as the:

- origin of coracobrachialis and short head of biceps brachii
- insertion for pectoralis minor

The origin of the long head of biceps brachii muscle is the supraglenoid tubercle. Insertion is into the ipsilateral radial tuberosity.

Although plain radiographs are not a conventional means of examining musculature, this example demonstrates the trapezius and deltoid muscles nicely outlined by less dense fat.

Case 10.8

Case 10.8

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	What originates from the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure that is outlined and labelled E.	

Case 10.8

A Capitulum of distal humerus

B Common flexor tendon

C Coronoid process of ulna

D Proximal diaphysis of radius

E Trochlea of distal humerus

The distal humerus comprises medial and lateral epicondyles, capitulum and trochlea.

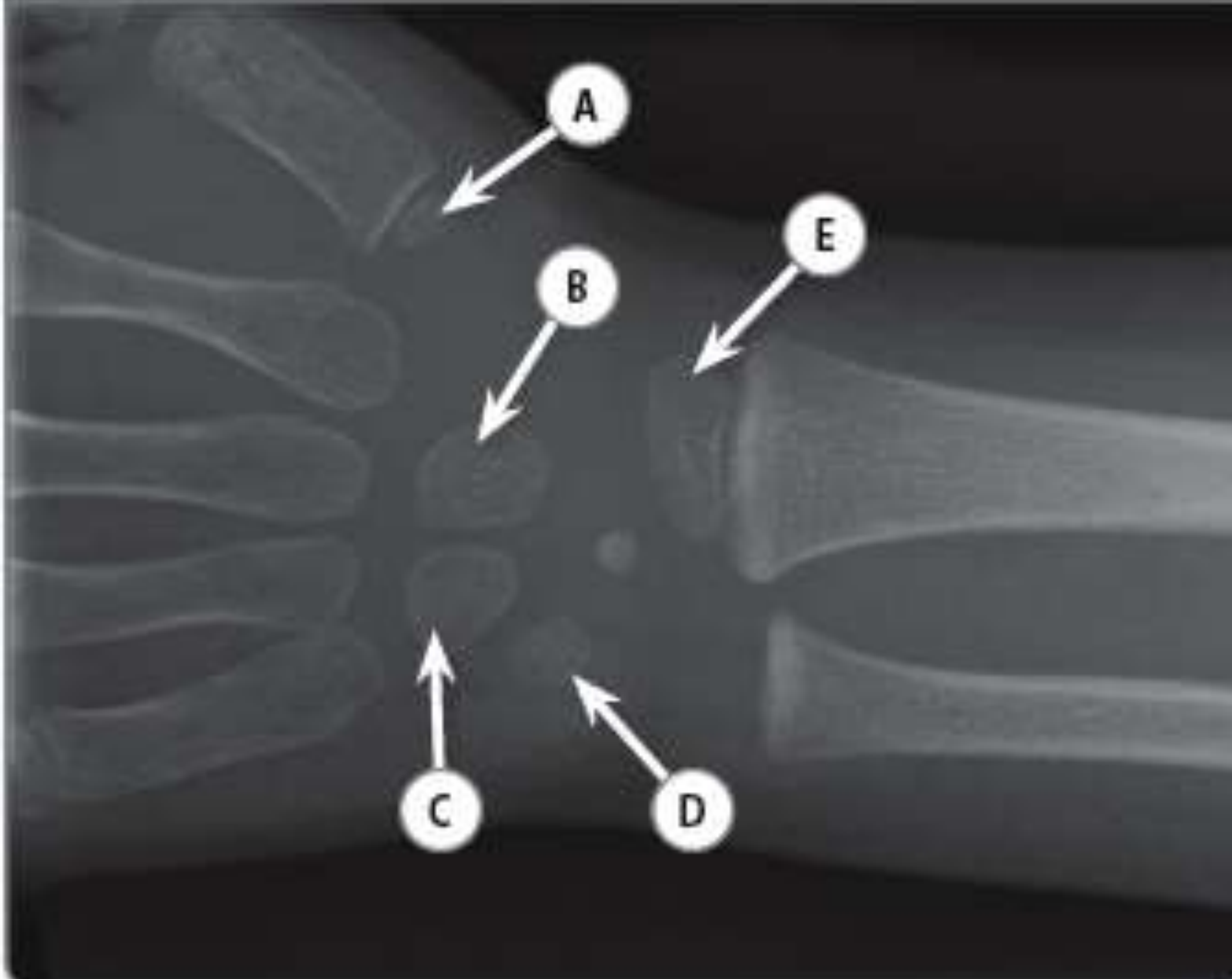
The medial epicondyle is the origin for the common flexor tendon, a tendinous origin for the following muscles:

- Pronator teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, flexor digitorum superficialis muscles.

The lateral epicondyle is the origin of the common extensor tendon, a tendinous origin for the following muscles:

- Extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi, extensor carpi ulnaris muscles.

Case 11.19



Case 11.19

A First metacarpal epiphysis

B Capitate

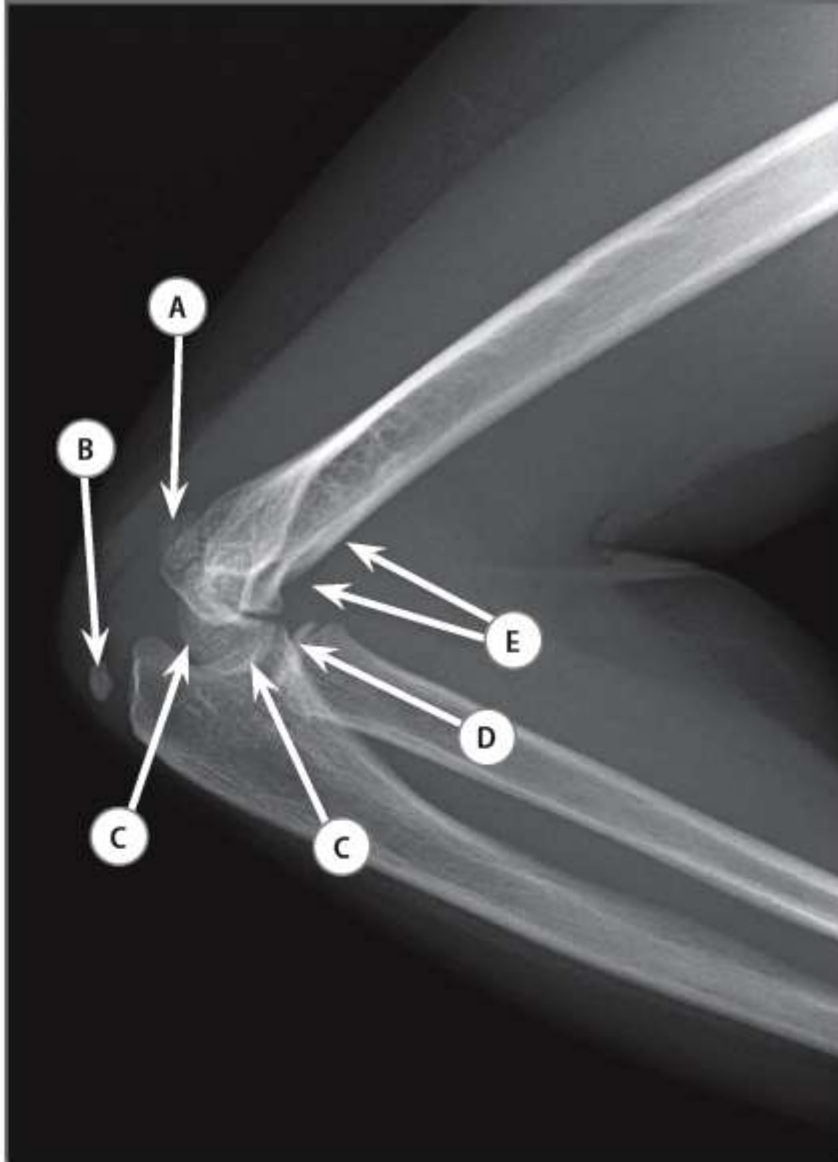
C Hamate

D Triquetral

E Distal radial epiphysis

The ossification status of the bones of the hand and wrist is used to evaluate skeletal maturity ('bone age'), e.g. in precocious puberty or growth restriction. The capitate and hamate are the first two carpal bones to ossify (within the first year of life) and as such are seen here to be the two most developed carpal bones. The triquetral is usually the next carpal bone to ossify, followed by the lunate (the smallest ossification centre to be seen here). No further carpal ossification centres are evident in this case. The pisiform is typically the last of the carpal bones to ossify.

Case 12.6



Case 12.6

A Medial epicondyle ossification centre

B Olecranon ossification centre

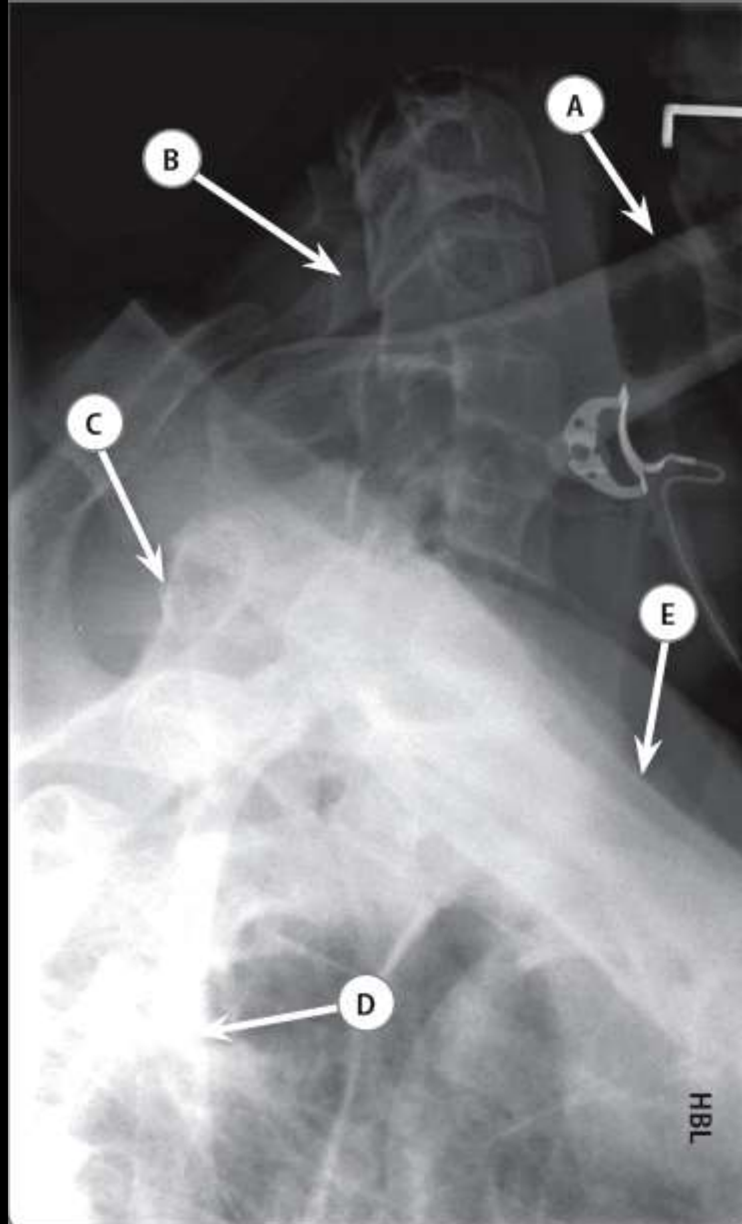
C Capitulum ossification centre

D Radial head ossification centre

E Anterior fat pad

The anterior fat pad corresponds to the intracapsular layer of fat located between the synovial membrane and the capsular ligament in the coronoid fossa – this is a normal finding. However, in the context of trauma, elevation of this fat pad, or visualisation of a posterior fat pad (i.e. intracapsular fat between the synovial membrane and capsular ligament in the olecranon fossa) is strongly suggestive of an elbow joint effusion and implies the presence of a fracture. The olecranon ossification centre (usually the penultimate ossification centre to be visualised, with the lateral epicondyle representing the last ossification centre to develop) is best appreciated on the lateral view. The medial epicondyle ossification centre should normally overlap the posterior aspect of the humerus on the lateral view; if not, avulsion should be suspected.

Case 13.19



Case 13.19

A Humerus

B Lamina

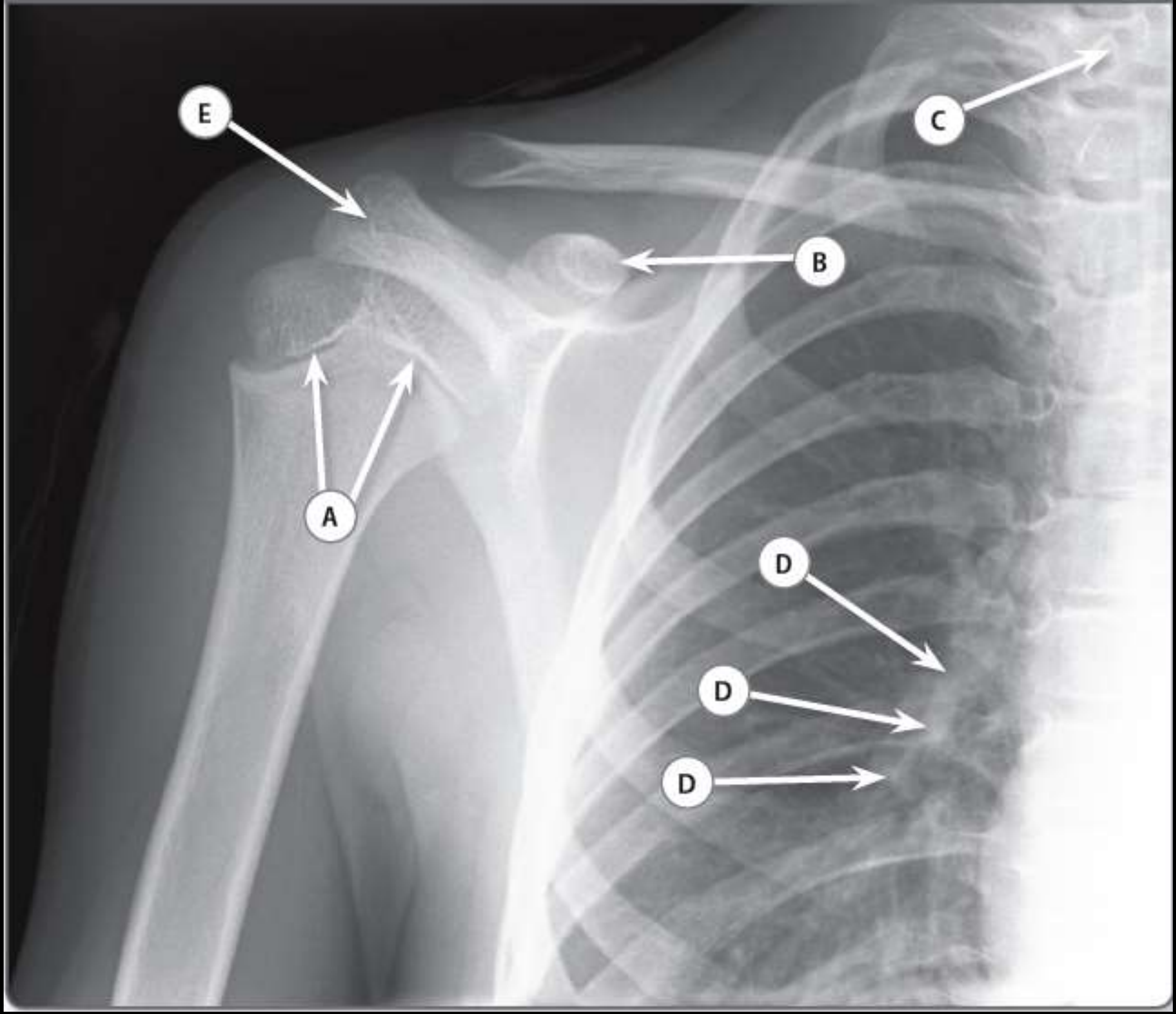
C Left coracoid process

D Blade of scapula

E Left clavicle

The purpose of the swimmer's view is to improve visualisation of the C7/T1 junction by ensuring that the humeral heads are projected away from the cervical spine, which is particularly important since a significant proportion of trauma to the cervicothoracic spine occurs at this level. Views like this may cause confusion but can still crop up in examinations. It is important to recognise the other structures that can appear on this view (including clavicle, humerus and scapula).

Case 15.14



Case 15.14

A Right proximal humeral epiphyseal plate

B Right coracoid

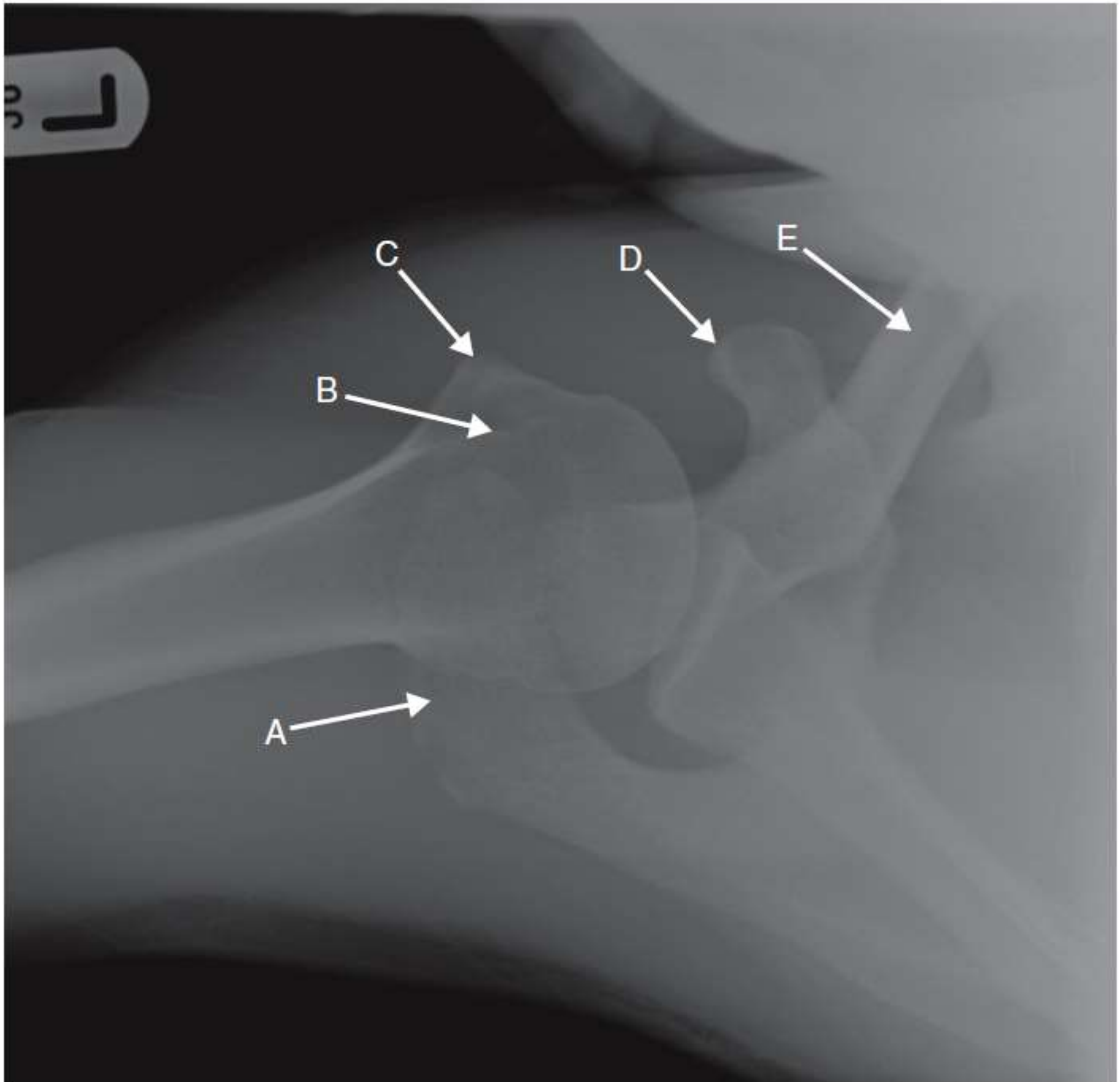
C Spinous process of T1

D Right lower lobe pulmonary artery

E Right acromion

The scapula ossifies from at least seven different centres. A large proportion of the scapula ossifies in utero. The coracoid and acromion each have two ossification centres which begin to ossify between the 14th and 20th months of age. Ossification of the scapula is normally complete by 25 years of age. Ossification centres of the head, lesser tuberosity and greater tubercles of the humerus develop separately but fuse together to form the epiphysis. The proximal humeral epiphyseal plate is cone-shaped (with the apex pointing posteriorly, medially and superiorly) and usually fuses by the age of 22 years.

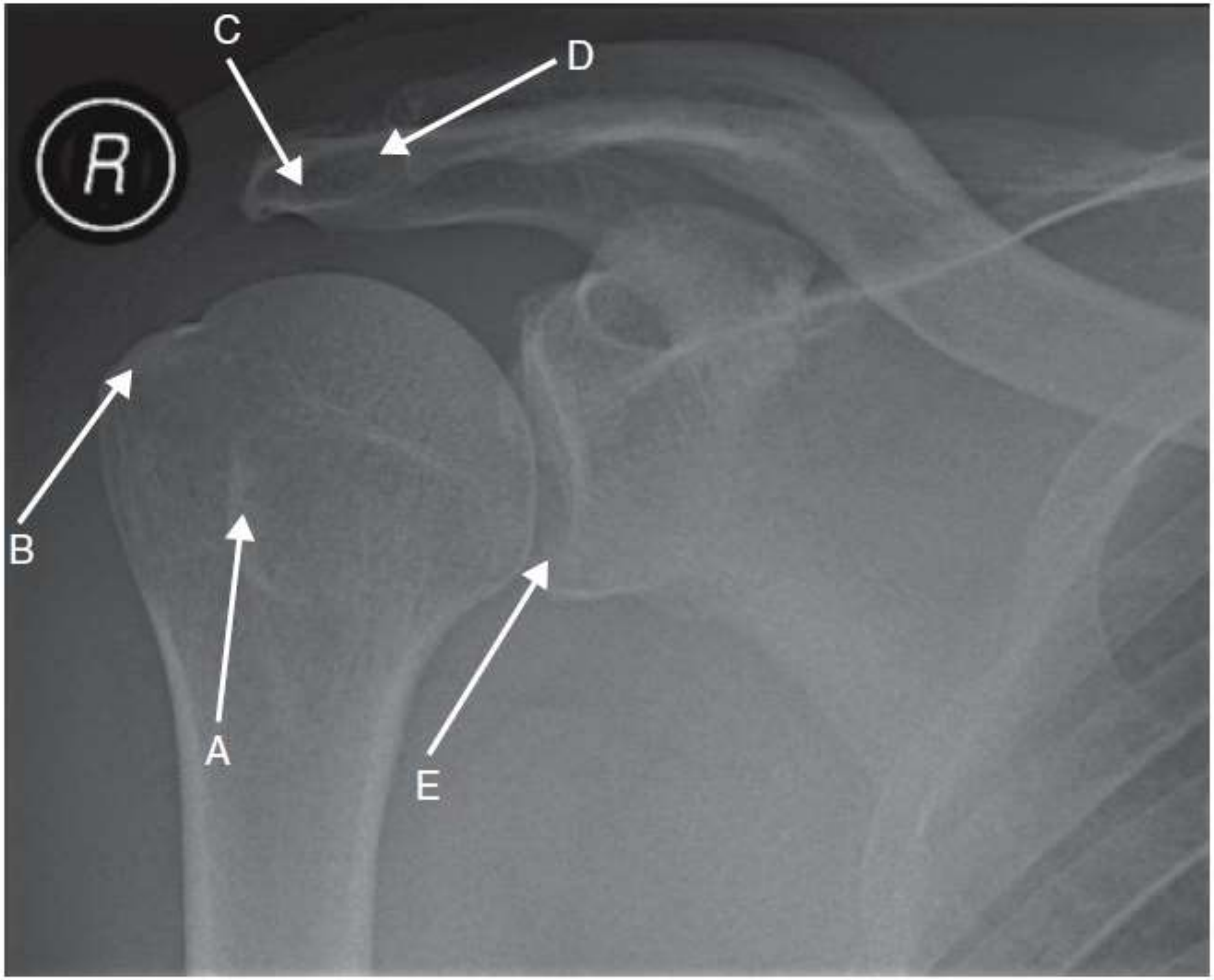
Case 2.19



2.19 Axial radiograph of the shoulder

(a) Acromion.
(b) Intertubercular groove.
(c) Lesser tuberosity.
(d) Coracoid process.
(e) Clavicle.

Case 4.1



4.1 AP radiograph right shoulder

(a) Lesser tuberosity of the right humerus. The subscapularis tendon attaches here. This may rarely become avulsed during hyper-external rotation injury due to traction by the subscapularis tendon insertion.

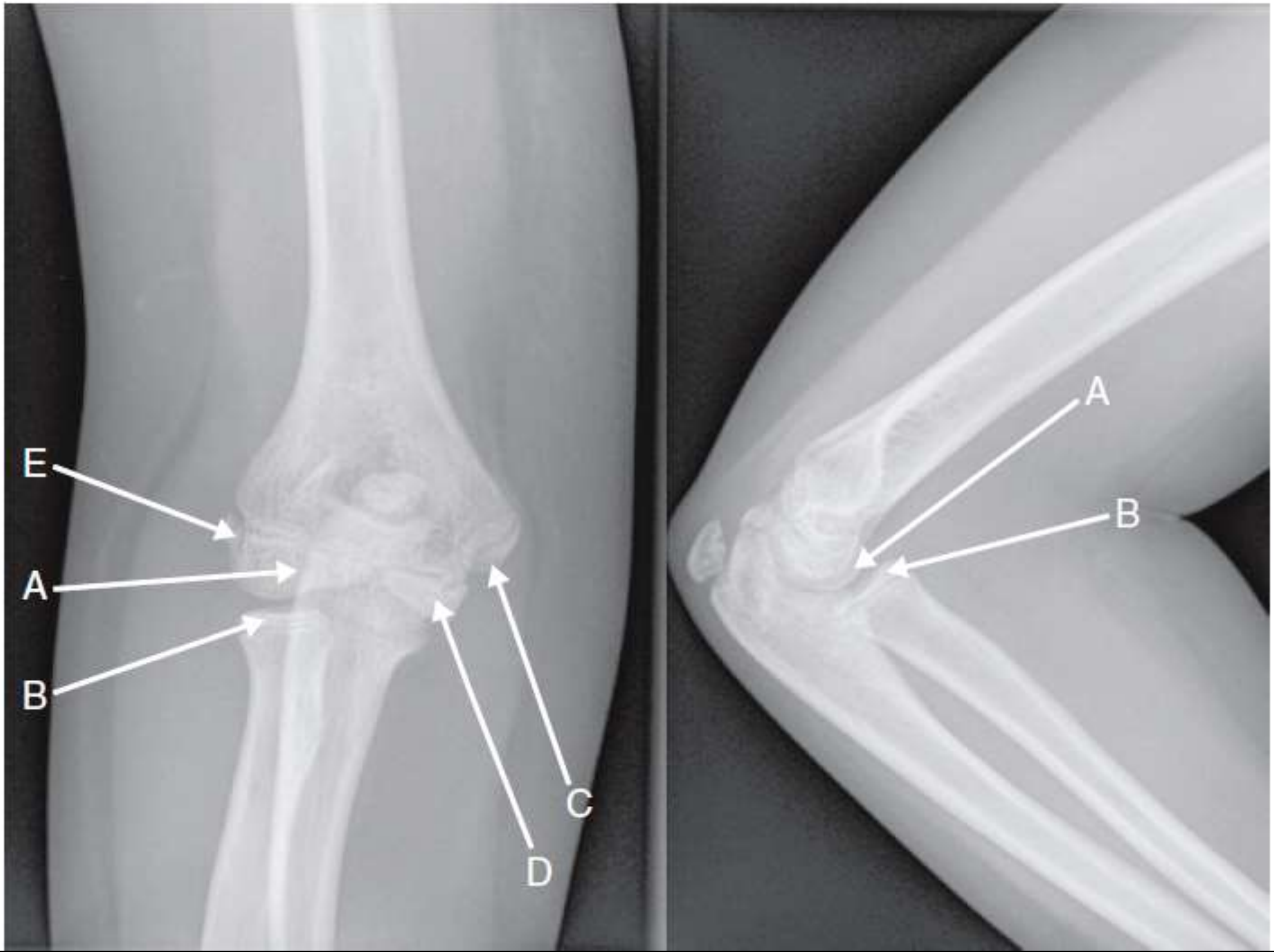
(b) Greater tuberosity of the right humerus. This forms the bony footprint for the supraspinatus tendon.

(c) Right acromion. The coraco-acromial ligament attaches from here to the coracoid process, forming a roof over the shoulder joint. Bony enthesopathy of this ligament may contribute to subacromial impingement of the supraspinatus tendon and is implicated as a causative factor in the evolution of rotator cuff tears.

(d) Right acromio-clavicular joint. This narrow synovial joint commonly undergoes degenerative changes but may also develop erosions in inflammatory arthropathy.

(e) The antero-inferior glenoid rim. This bears the attachment of the anterior band of the inferior glenohumeral ligament, which is an important static stabilizer of the glenohumeral joint. This region may be fractured during anterior glenohumeral dislocation, producing a bony Bankart lesion.

Case 4.11



4.11 AP and lateral radiograph left elbow

(a) Capitellum.
(b) Radial head.

http://dx.doi.org/10.1017/CBO9781139087384.011

(c) Medial (or internal) epicondyle.
(d) Trochlea.
(e) Lateral epicondyle.

Ossification order and times:
Capitellum – in the first year
Radial head – 5 years
Medial epicondyle – 7 years
Trochlea – 9 years
Olecranon – 11 years
Lateral epicondyle – 13 years.

While there is wide variation in ossification timing, the order of appearance of ossification is usually maintained, which therefore is more valuable to know rather than the exact dates. Sexual dimorphism should be recognized with female elbows usually ossifying and fusing earlier than males. The mnemonic CRITOL is an invaluable reminder for this order.

The ossification order assumes significance because the medial epicondyle can be avulsed and displaced into the joint. In this situation there will be an apparent well-formed trochlea with no apparent ossification of the medial epicondyle, in a child younger than 9 years. In an older child there may appear to be a fragmented or bifid trochlea, but no medial epicondyle. There may be other clues to a significant injury being present including soft tissue swelling or a joint effusion. However, soft tissue swelling may be minimal as this injury is often an avulsion injury and not direct trauma. A joint effusion may not be present if there is disruption of the joint capsule allowing the effusion to escape into the soft tissues without raising the anterior and posterior fat pads that are usually apparent with elbow joint effusions. In some cases CT or MRI assessment may be required to confirm or exclude injury.

Case 11.1

Case 11.1

- **A** Olecranon of the ulna
- **B** Proximal diaphysis of the ulna
- **C** Distal diaphysis of the humerus
- **D** Triceps brachii muscle
- **E** Head of radius

On the lateral radiograph of the elbow, the trochlea and capitulum of the distal humerus are superimposed on one another.

There are two fundamental lines that must be reviewed on the lateral radiograph (with the elbow flexed at 90°) in order to confidently exclude displaced fractures and dislocations:

1. The normal anterior humeral line will have at least one third of the capitulum anterior to it. This line is drawn along the anterior aspect of the distal humeral diaphysis and through the elbow joint.
2. The normal radiocapitellar line passes through the middle of the capitulum. This line is drawn centrally through the proximal radius and through the elbow joint.

Case 5.11

5.11 Lateral wrist radiograph

(a) Lunate.
(b) Capitate.
(c) Trapezoid.
(d) Scaphoid.
(e) Pisiform.

Case 6.5

(e) Name the structure in which the sesamoid bone labelled E lies.

6.5 Dorso-palmar (DP) radiograph left hand

(a) Radial styloid process. This forms the dorsal and radial margins of the radio-carpal joint and may become fractured during forced radial and dorsal deviation of the wrist due to impaction by the scaphoid. This fracture was traditionally termed the 'chauffeur's fracture' due to the mechanism of injury sustained by turning a stiff crankshaft on old cars.

(b) Distal radio-ulnar joint (DRUJ). The DRUJ is a synovial joint formed by the sigmoid notch of the radius and the convex articular surface of the ulna. It is important as it facilitates wrist supination and pronation whilst the elbow is fixed. The distal margin of the joint is covered by the triangular fibrocartilage (TFC) and its supporting ligaments, thus TFC injury can lead to DRUJ instability.

(c) Ulnar styloid. The ulnar styloid projects distally from the dorsal aspect of the distal ulnar. It bears attachment of many important structures including the supporting ligaments of the TFC and the sheath of the extensor carpi ulnaris tendon. It is commonly avulsed during wrist trauma by traction of these structures, which frequently results in fracture non-union.

(d) Trapezium. This forms a synovial saddle joint with the base of the metacarpal of the thumb. This joint is a common site for primary osteoarthritis due to its frequent use.

(e) Flexor pollicis longus (FPL). The paired FPL sesamoids are present in nearly all individuals and lie either side of the FPL tendon beneath the metacarpo-phalangeal (MCP) joint of the thumb. They are analogous to the paired flexor halluces longus (FHL) sesamoid bones found beneath the metatarso-phalangeal (MTP) joint of the hallux.

Case 6.18

6.18 Lateral radiograph right wrist

(a) Trapezium.
(b) Lunate.
(c) Pisiform.
(d) Scaphoid.
(e) Ulnar styloid.

Case 7.19

7.19 Y-view right shoulder radiograph

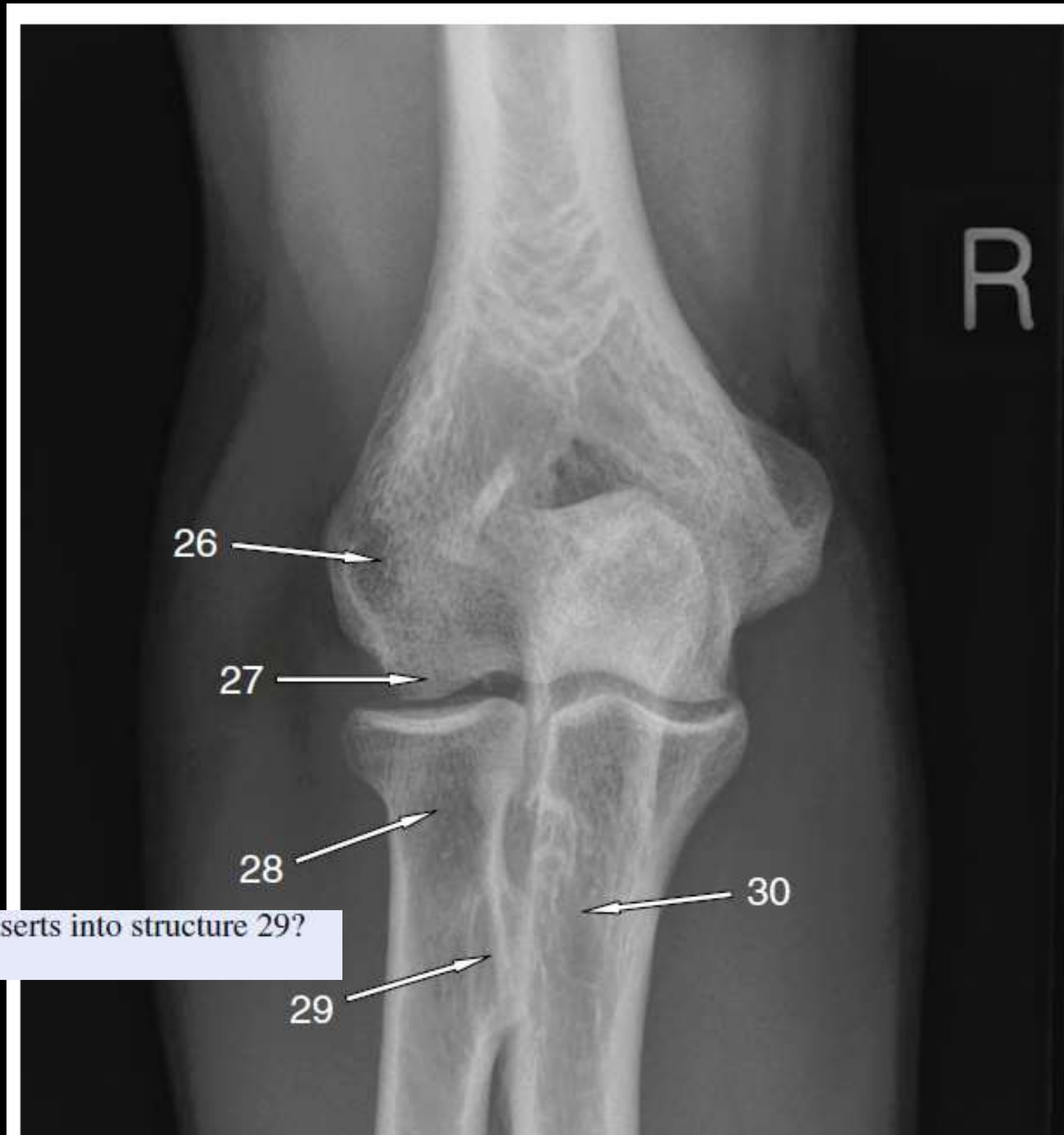
(a) Acromion.
(b) Clavicle.

(c) Coracoid process.
(d) Glenoid.
(e) Lateral scapular border.

Case 8.18

8.18 AP radiograph of paediatric wrist

(a) Radial styloid epiphysis.
(b) Base of thumb epiphysis.
(c) Hook of hamate.
(d) Capitate.
(e) Trapezoid.



What muscle inserts into structure 29?

Elbow Radiograph

26. Right lateral epicondyle of humerus
27. Right capitellum of humerus
28. Right neck of radius
29. Right biceps brachii muscle
30. Right shaft of ulna


R
33
34
35
32
31

Hand Radiograph

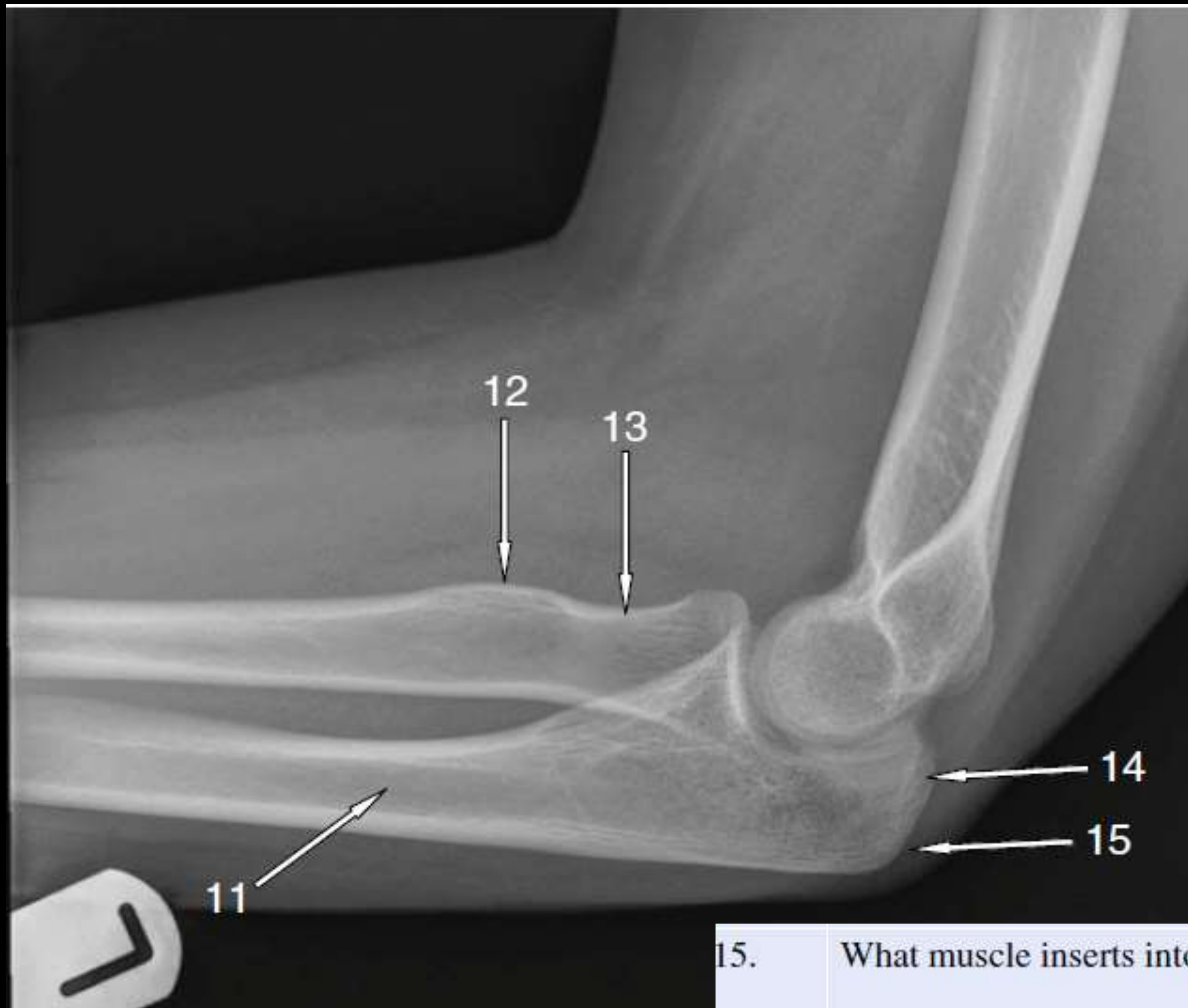
31. Right styloid process of ulna
32. Right trapezium
33. Right capitate
34. Right lunate
35. Right head of thumb metacarpal

Phalanges and metacarpals should be named (not numbered) according to the corresponding digit, e.g. thumb not 1st metacarpal.


6
7
8
9
10
Right
kV 60 mAs

Wrist Radiograph

6. Base of right thumb metacarpal
7. Right trapezium
8. Right scaphoid
9. Base of right little finger metacarpal
10. Styloid process of right ulna



15.	What muscle inserts into 15?

Elbow Radiograph

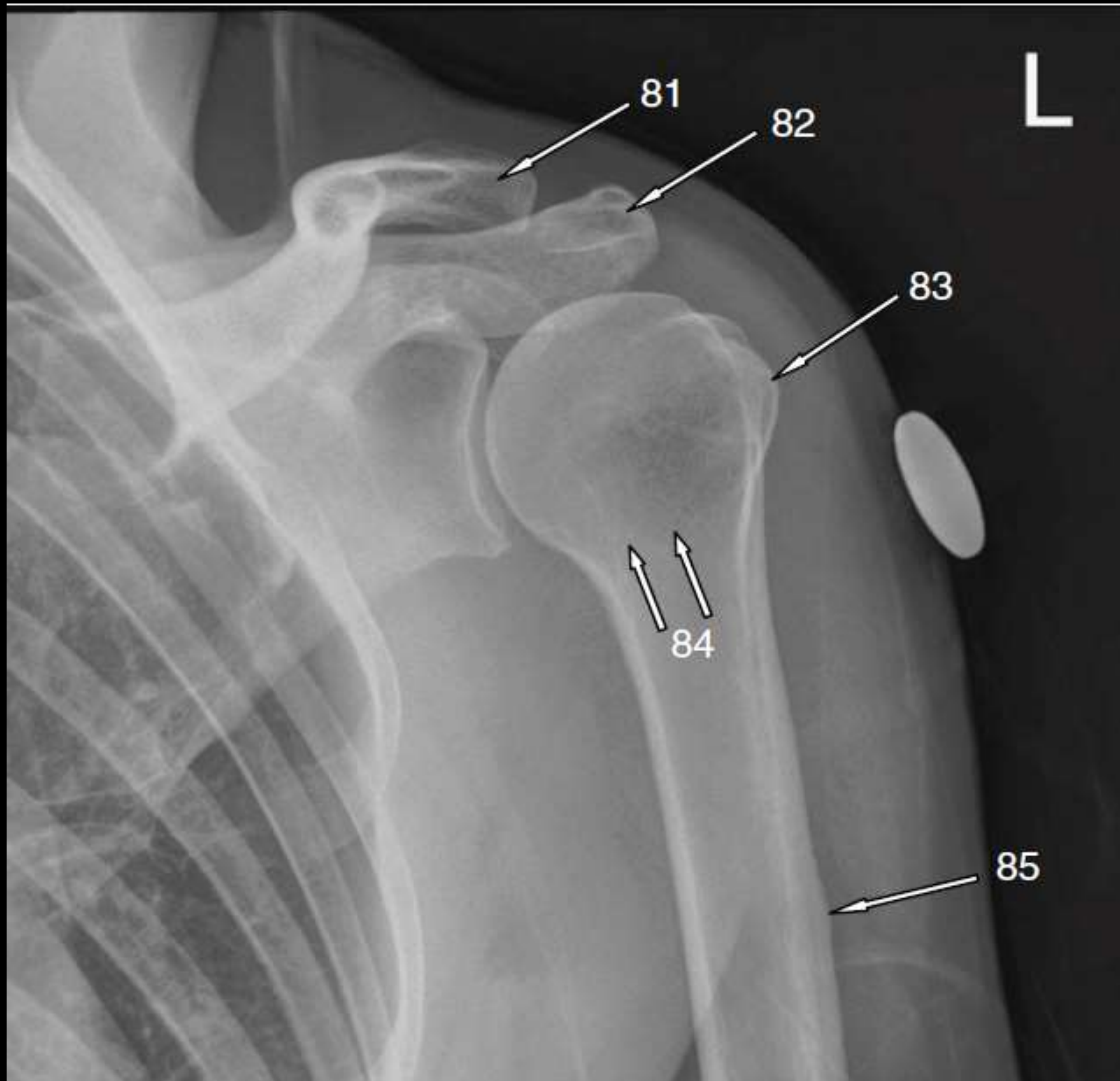
11. Left shaft of ulna
12. Left tuberosity of radius
13. Left neck of radius
14. Left olecranon of ulna
15. Left triceps brachii muscle

Another possible question is what muscle inserts into 12? (Biceps brachii muscle)


L
30
29
28
27
26

Hand Radiograph

26. Left lunate bone
27. Left scaphoid bone
28. Left trapezium
29. Sesamoid bone at left thumb metacarpophalangeal joint
30. Proximal interphalangeal joint (PIPJ) of left index finger


L
81
82
83
84
85

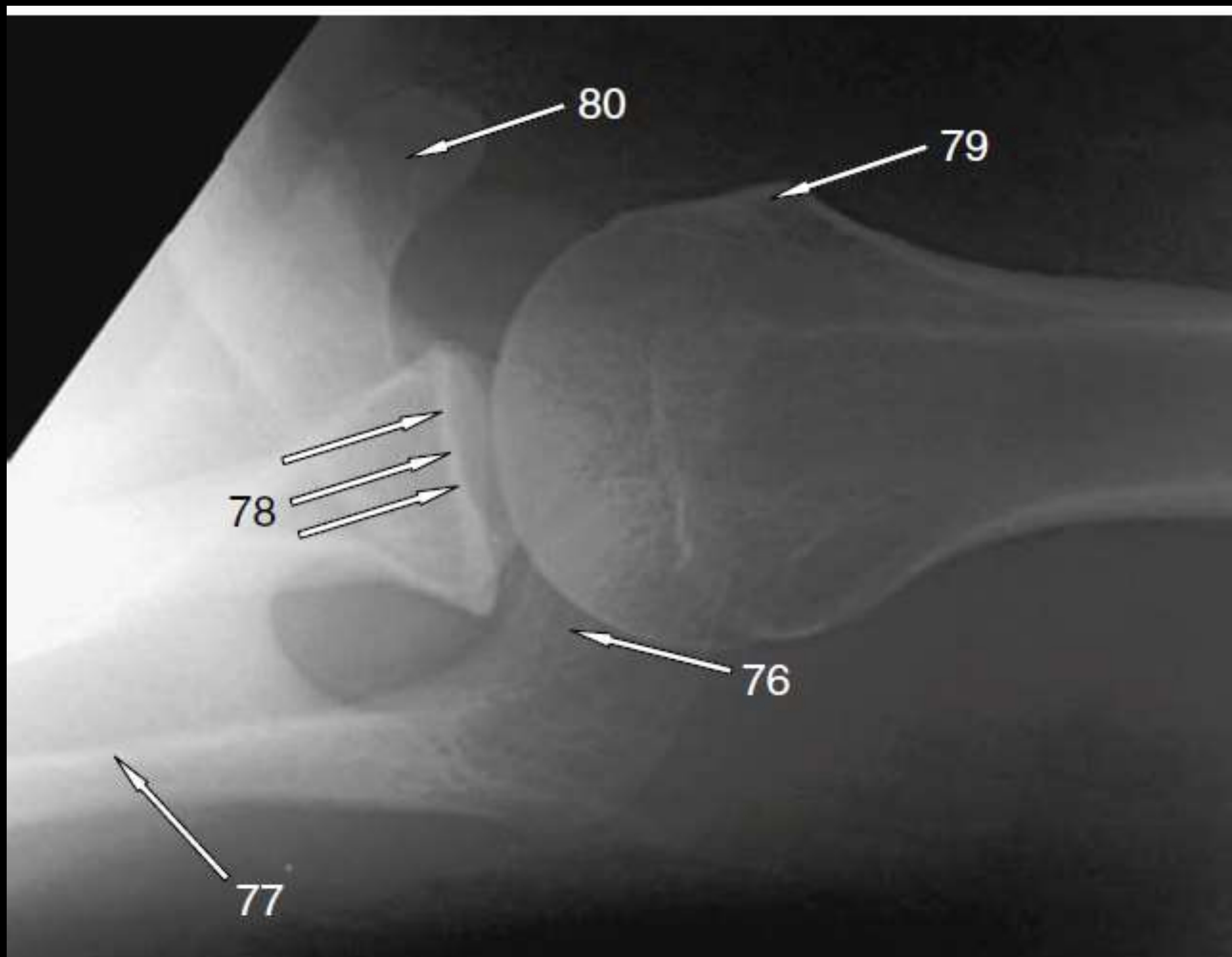
Shoulder Radiograph

81. Left clavicle
82. Acromion process (of left scapula)
83. Left greater tuberosity of humerus
84. Left surgical neck of humerus
85. Left deltoid tuberosity of humerus


72
73
74
75
71

Elbow Radiograph

71. Tuberosity of right radius
72. Olecranon fossa of right humerus
73. Lateral epicondyle of right humerus
74. Capitellum of right humerus
75. Coronoid process of right ulna



80
79
78
76
77

Shoulder Radiograph

76. Acromion process of scapula
77. Spine of scapula
78. Glenoid fossa
79. Greater tuberosity of humerus
80. Coracoid process of scapula

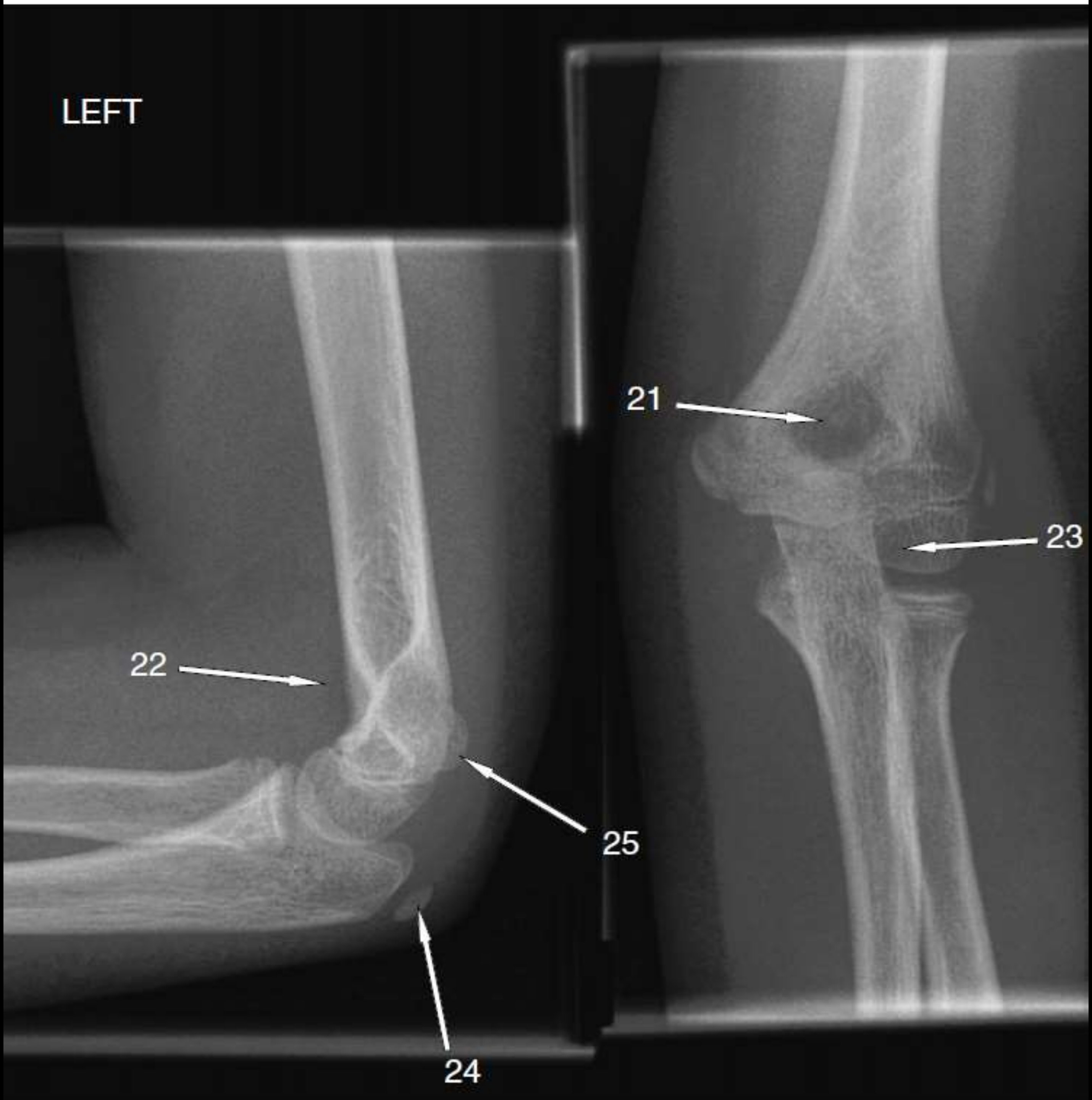
The coracoid process is the most anterior part of the scapula. This should help you identify the other features on this image.

90
87
89
86
88
R

Wrist Radiograph

86. Right scaphoid
87. Right pisiform
88. Right lunate
89. Right capitate
90. Right thumb metacarpal

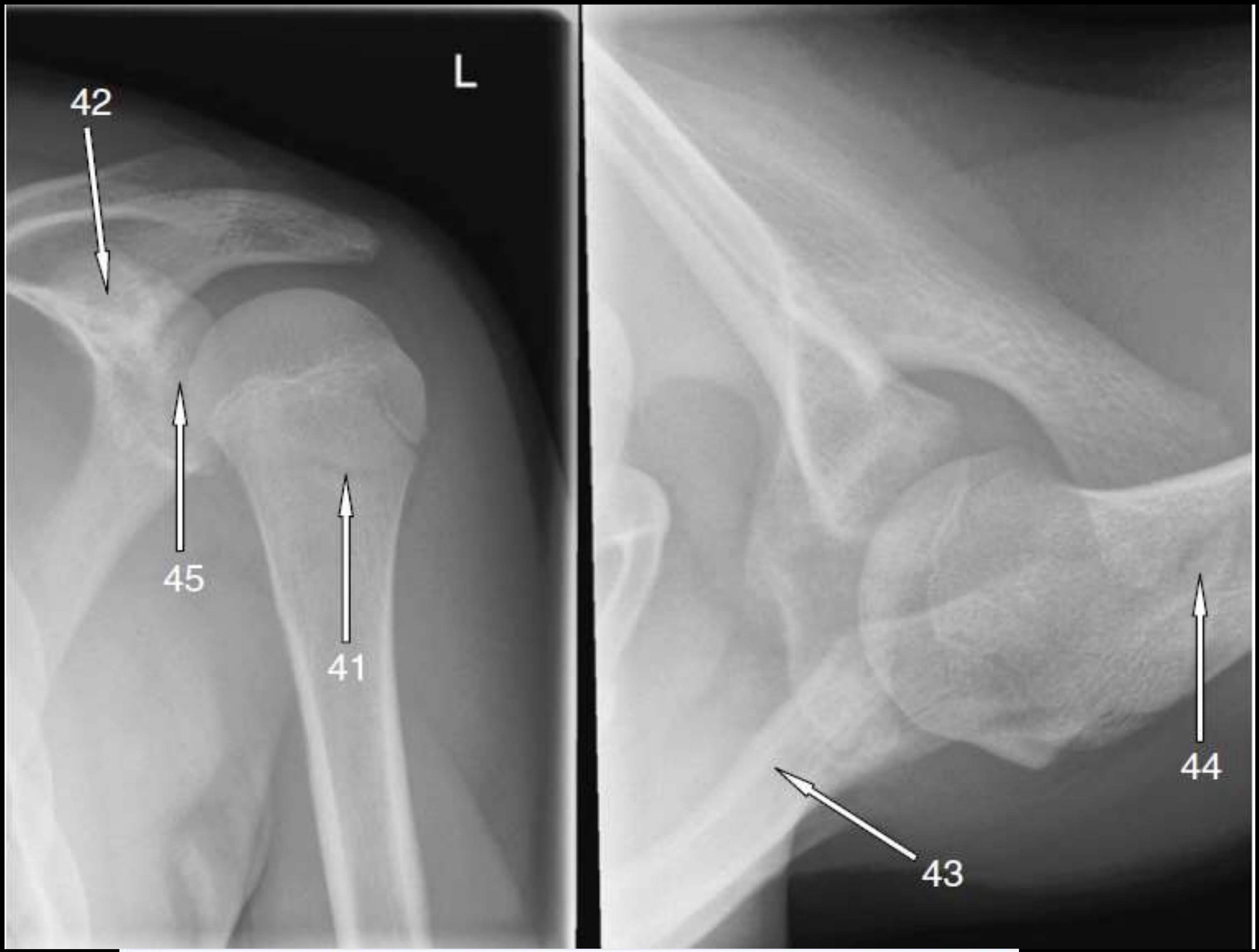
The lateral wrist X-ray is useful in determining lunate dislocation. Always look at the alignment of the lunate and capitate in these films. Failure to diagnose this disorder can result in permanent impairment of the median nerve if it is compressed by the lunate.


LEFT
21
22
23
24
25

Elbow Radiograph

21. Olecranon fossa left humerus
22. Normal anterior left humeral fat pad
23. Capitellum left humerus
24. Ossification centre of the olecranon of the left ulna
25. Ossification centre of the left medial epicondyle

The olecranon fossa may be fenestrated as a normal variant. The anterior fat pad is elevated in the presence of an elbow joint effusion but is less specific for fracture than an elevated posterior fat pad, which should never normally be visible.



Name the structure labelled 44, projected over the proximal humerus.

Shoulder Radiograph

41. Left proximal humeral growth plate
42. Coracoid process of left scapula
43. Left clavicle
44. Acromion of left scapula – ossification centre
45. Glenoid fossa of left scapula

The undulating growth plate of the proximal humerus is often mistaken for a fracture, as is the late to ossify secondary ossification centre of the acromion. Unossified acromion makes assessment of the acromioclavicular joint difficult in younger children.

Name the normal variant

Shoulder Radiograph

Os acromiale

This relatively common accessory ossicle results from failure of fusion of the secondary ossification centre of the acromion. Not to be mistaken for a fracture!

Name the normal variant

Hand Radiograph

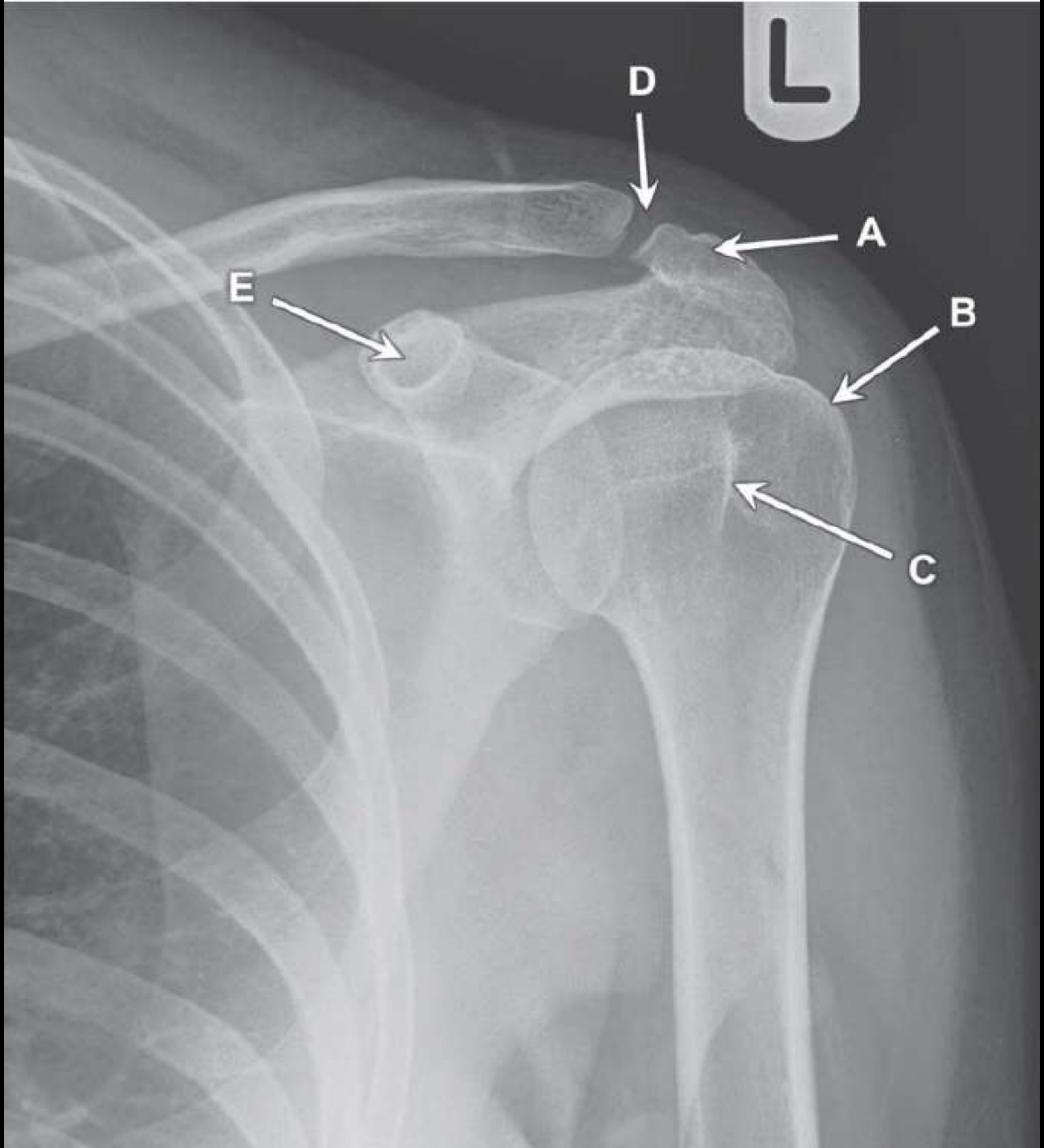
Coalition of lunate and triquetral
Carpal coalition is relatively uncommon but is a recognised normal variant. Look at the carpal bones, identify each one on an image, and you should be able to notice coalition when present.


D
A
B
E
C

Case 10

Plain radiograph. DP wrist.

1. Trapezium
2. Pisiform
3. Ulnar styloid process
4. Hook of the hamate
5. Scaphoid


L
D
A
E
B
C

Case 1

Plain radiograph. AP left shoulder.

1. Left acromion
2. Left greater tuberosity of humerus
3. Left lesser tuberosity of humerus
4. Left acromioclavicular joint
5. Left coracoid process of scapula


R
E
A
B
C
D

Case 12

Plain radiograph. Oblique hand and wrist.

1. Right trapezoid
2. Right hamate
3. Right lunate
4. Right capitate
5. Sesamoid bone

R
A
E
C
D
B

Case 11

AP radiograph. Right thumb (paediatric)

1. Right proximal epiphysis of the proximal phalanx of the thumb
2. Right hamate
3. Right trapezium
4. Right trapezoid
5. Right proximal epiphysis of the first metacarpal

It is potentially easy to mistake unfused epiphyses for separate bones, for example the structure labelled E. Beware.


L
C
E
B
D
A

Case 15

Plain radiograph. AP elbow.

1. Radial tuberosity (left)
2. Trochlea (left)
3. Olecranon process of the ulna (left)
4. Coronoid process of the ulna (left)
5. Olecranon fossa (left)

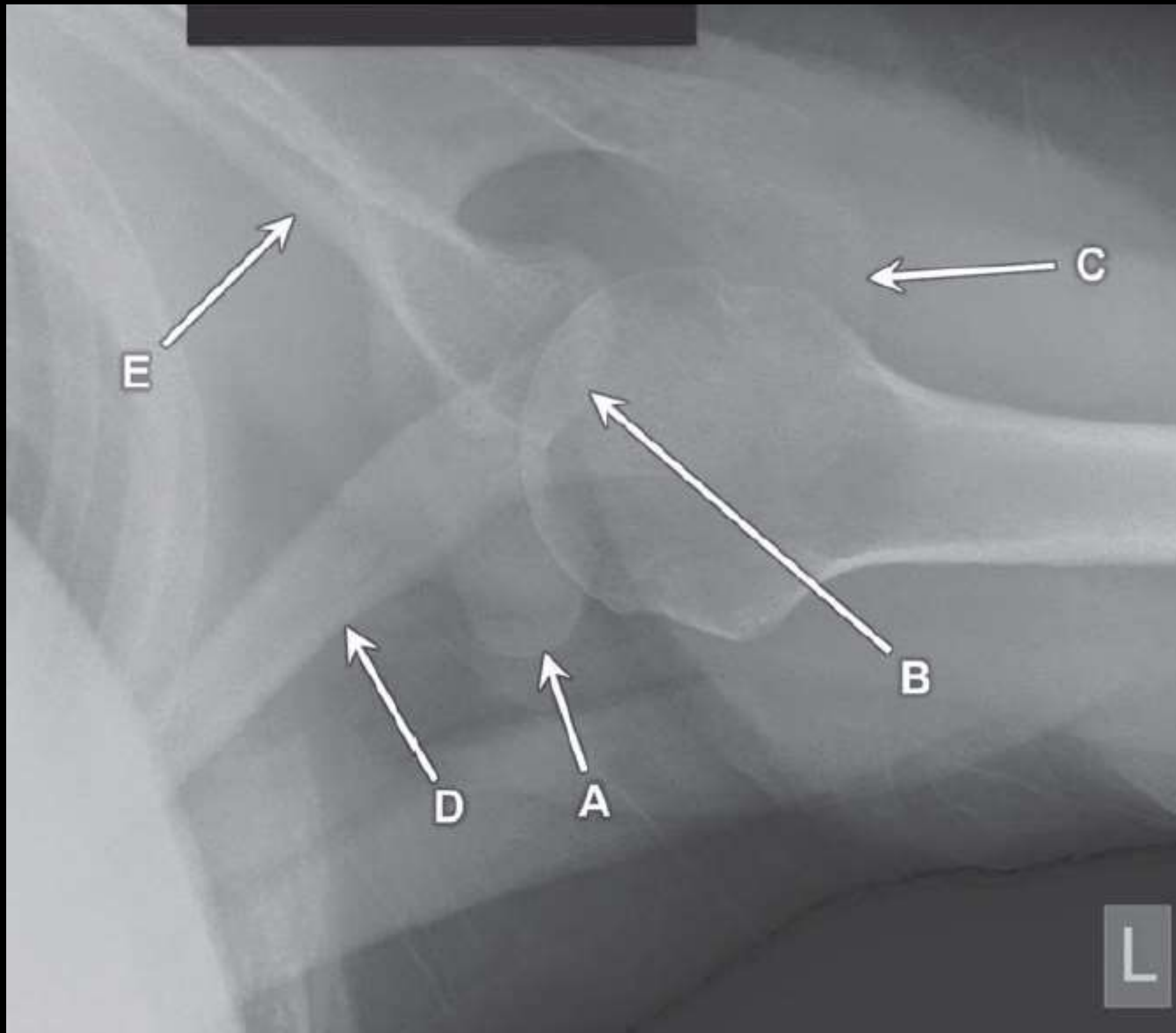

A
B
C
D
E

Case 20

Lateral radiograph of the thumb

1. Pisiform
2. Scaphoid tubercle
3. Lunate
4. Ulna
5. Radius

Differentiating the ulna and radius is straightforward with a little careful examination. The bone labelled E is seen to articulate with the lunate so must be the radius; the bone labelled D does not and has the characteristic styloid process.


E
C
B
D
A
L

Case 7

Axial view of the shoulder.

1. Left coracoid process
2. Left glenoid
3. Left acromium
4. Left clavicle
5. Left scapula blade

In this view, it may be easy to mistake the scapular blade for the scapular spine. The spine, however, lies more posterior than this and is continuous with the acromium.

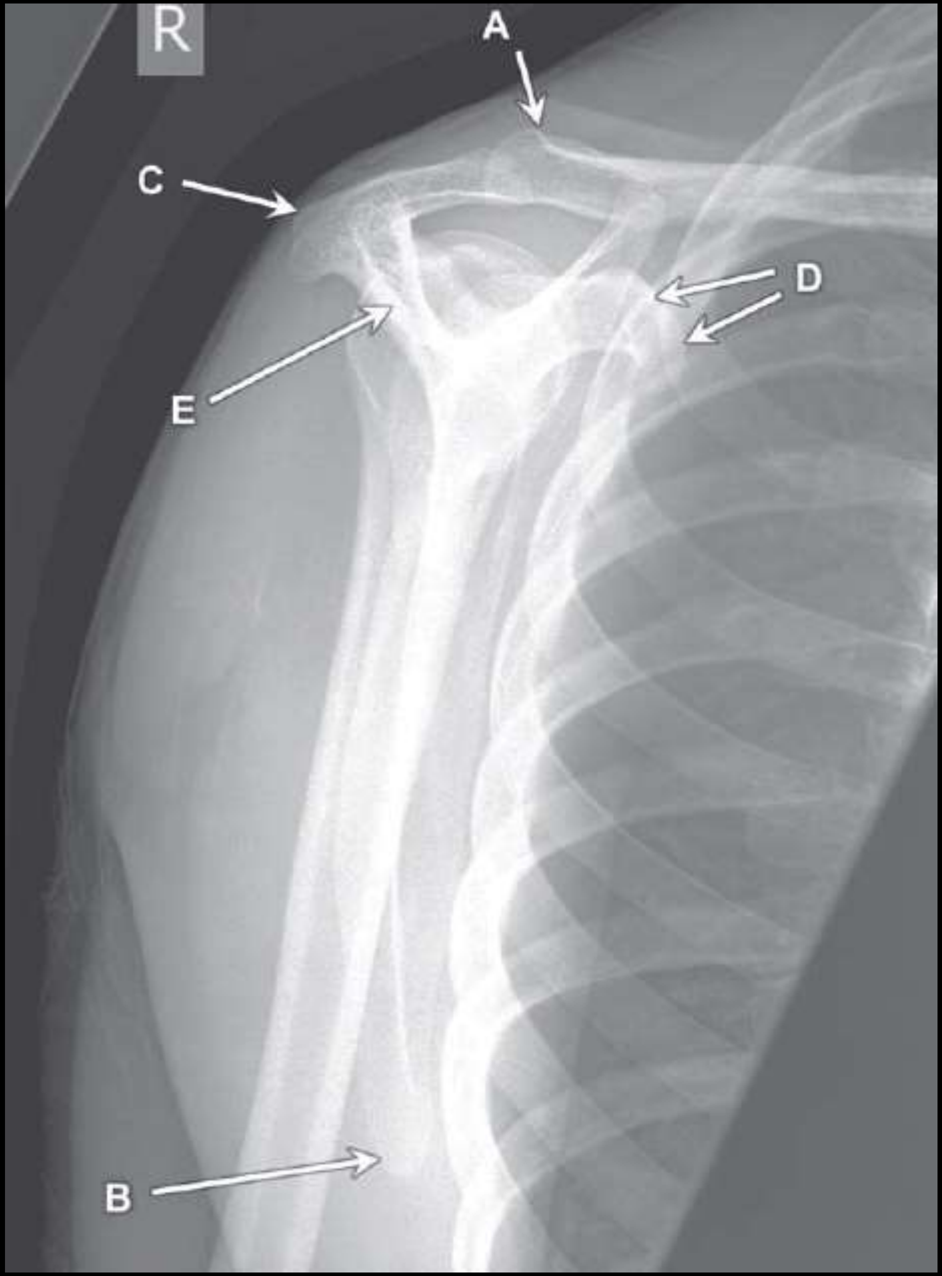

A
B
E
C
D

Case 9

Lateral wrist radiograph.

1. Fifth metacarpal
2. Second metacarpal
3. Ulna
4. Radius
5. Trapezium

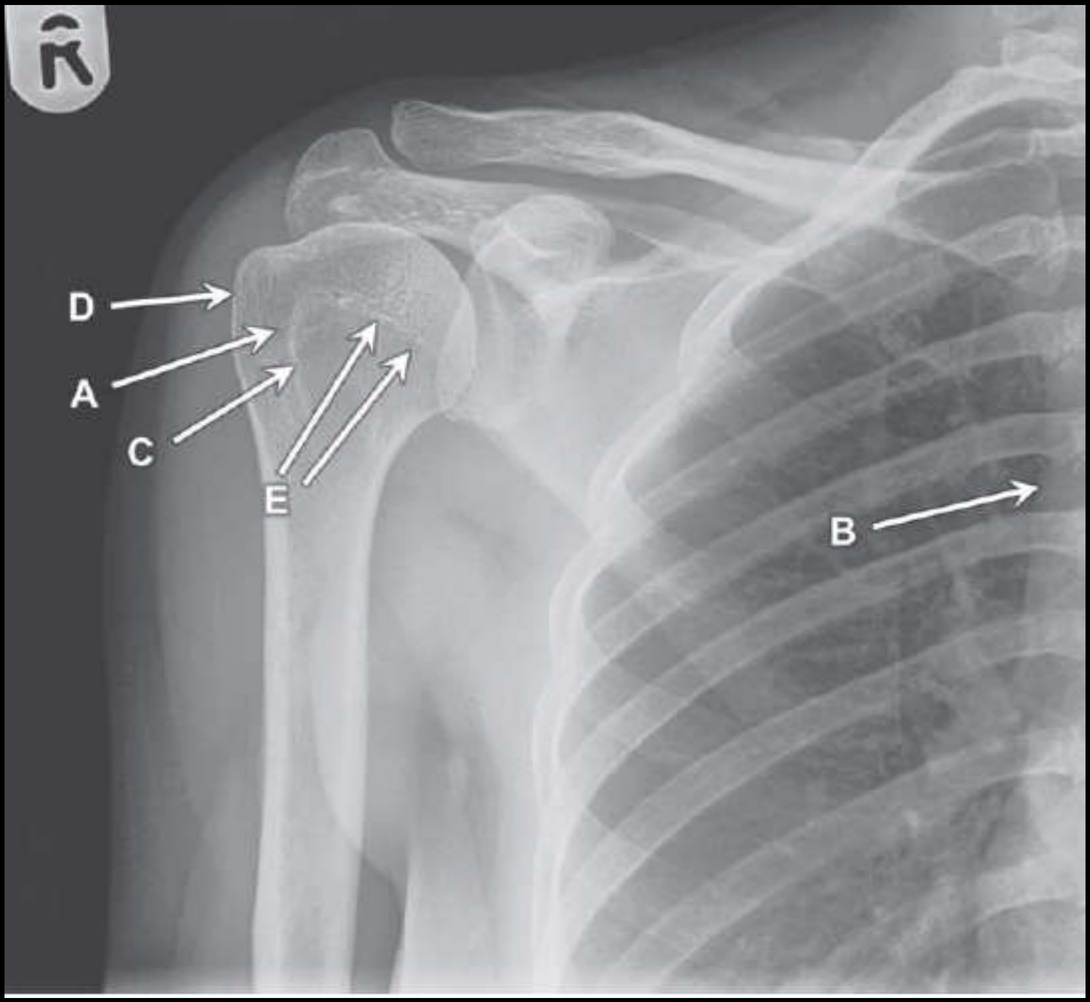
This is tricky but is achievable by looking at the articulations. 'A' is the smallest metacarpal so almost certainly number 5. 'B' is the second longest but too far away from 'A' to be the fourth. 'D' articulates directly with the lunate, so is the radius; C does not. 'E' articulates with the first metacarpal so is the trapezium.


R
A
C
D
E
B

Case 2

Plain radiograph. Shoulder 'Y' view.

1. Right clavicle
2. Inferior angle of the right scapula
3. Right acromium
4. Right coracoid process of the scapula
5. Right scapular spine


R
D
A
C
E
B

Case 13

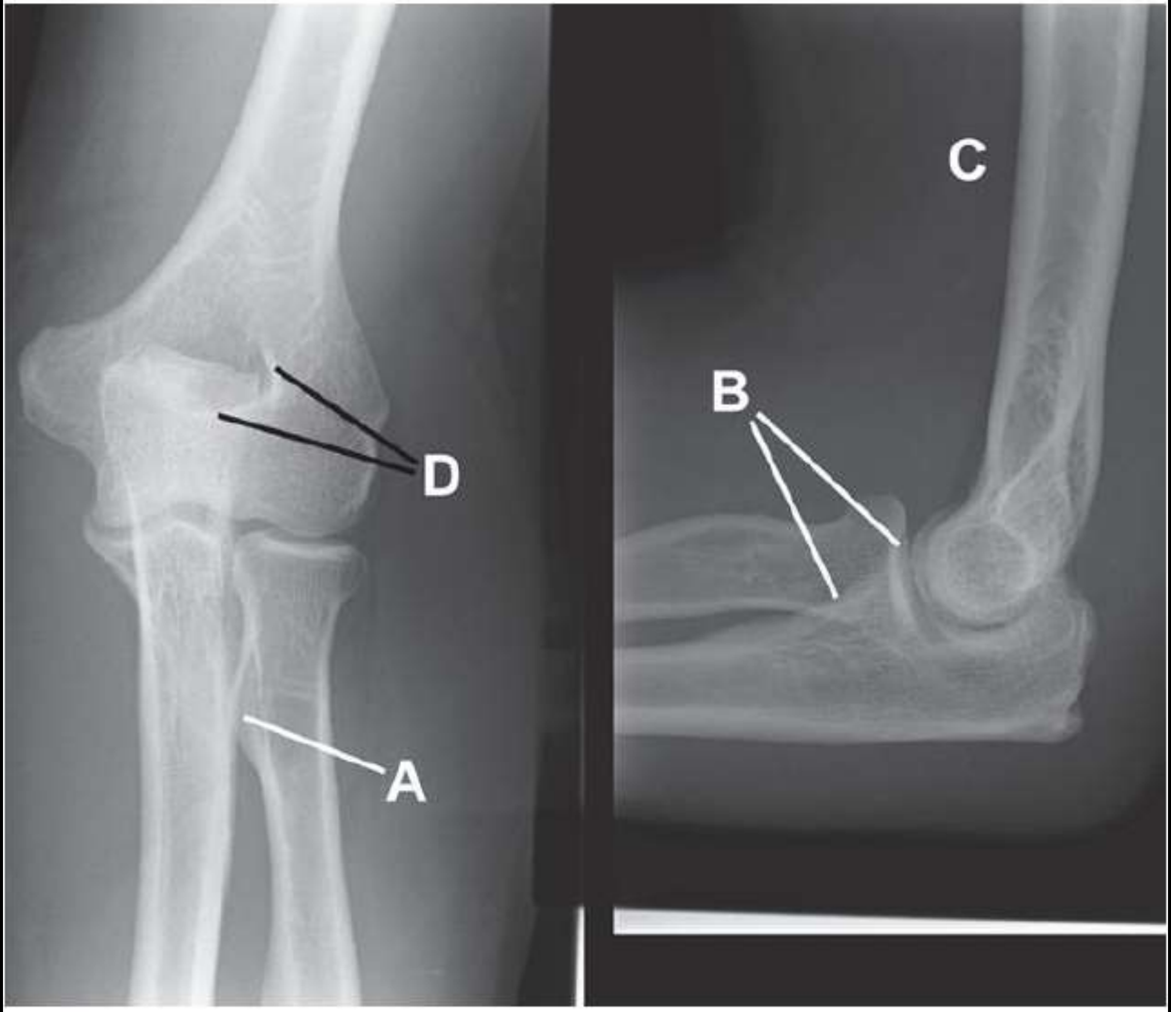
Plain radiograph. AP view of right shoulder.

1. Bicipital groove
2. Superior vena cava
3. Lesser tuberosity of the humerus
4. Greater tuberosity of the humerus
5. Anatomical neck of the humerus

The 'surgical neck' of the humerus is the region at the proximal diaphysis just distal to the tuberosities. This is the most common site of fractures.

Q2

a Name the structure that attaches to A
b Name the structure labelled B
c Name the muscles contained within the anterior humeral compartment at the level indicated
d Name the structure labelled D
e Name the major ligaments that join the humerus to forearm bones



Q2 Answers

a Tendon of biceps brachii muscle
b Coronoid process of ulna
c Biceps brachii and brachialis
d Olecranon fossa
e Medial and lateral (ulnar and radial) collateral ligaments

Radiographs of elbow, AP and lateral views

The major flexors of the elbow are the biceps brachii and brachialis muscles which lie within the anterior humeral compartment. Their action is aided by the brachioradialis muscle (particularly when the forearm is in the mid-prone position), the belly of which is contained within the forearm.

The elbow joint is stabilized medially and laterally by strong collateral ligaments which originate from the epicondyles of the humerus. These are also known as the radial and ulnar collateral ligaments. The radial collateral ligament is continuous with the annular ligament of the radius. The ulnar collateral ligament has three discrete bands; anterior, posterior and oblique joining it to the coronoid process and olecranon of the ulna.

Q14

a Name the structure that links the radius and ulna in the space labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the structures that the radial and ulnar arteries terminate as

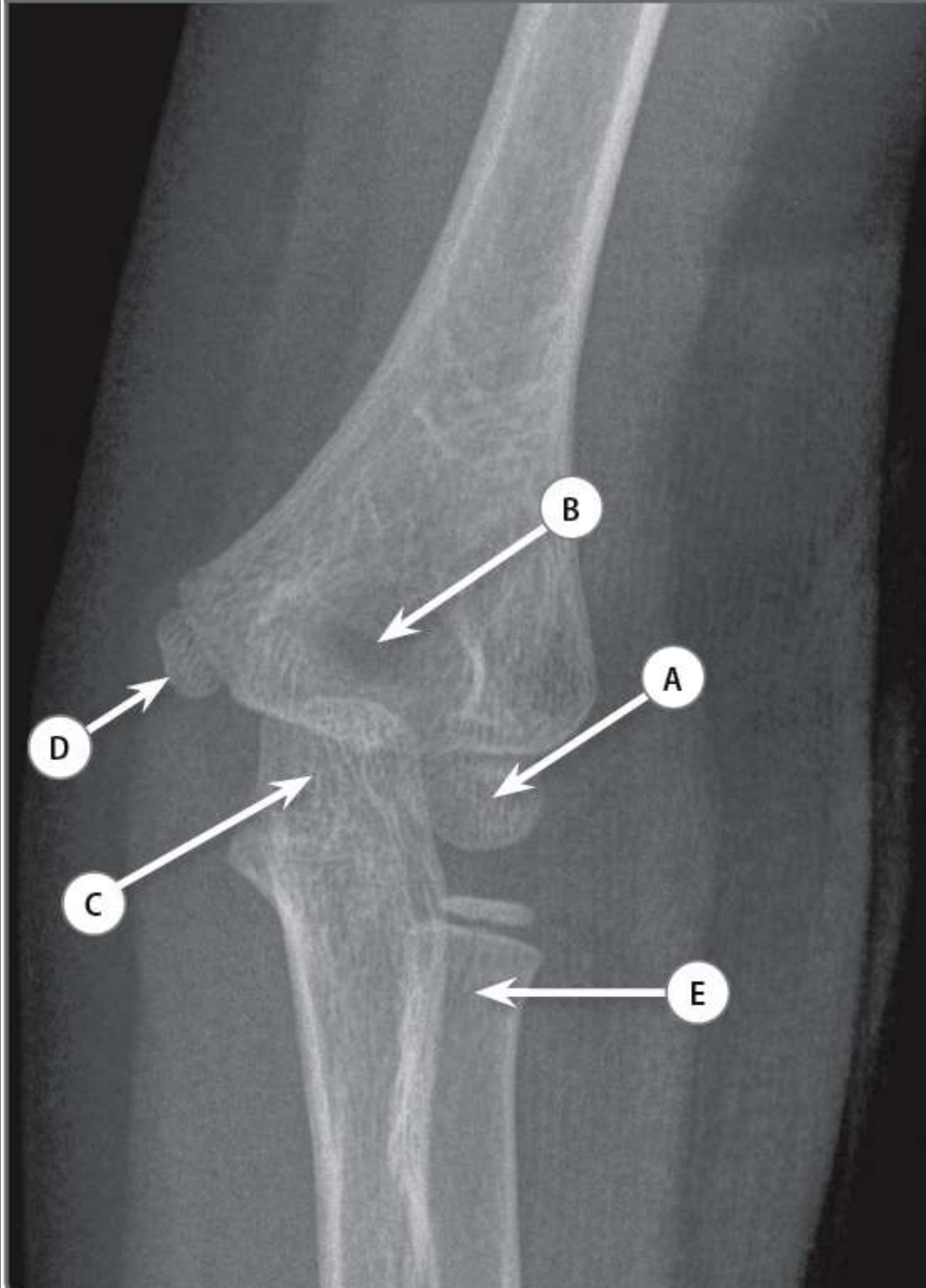
Q14 Answers

a Interosseous membrane
b Ulnar styloid
c Hook of hamate
d Epiphysis of thumb metacarpal
e Superficial and deep palmar arches

Radiograph of the wrist in a 13 year-old child, AP view

All carpal bones are visible in this image of an adolescent child and are almost fully ossified. The long bone epiphyses are similarly nearing their final size prior to fusion of the physes.

Case 5.10



Case 5.10

A Secondary ossification centre of the capitulum

B Olecranon fossa

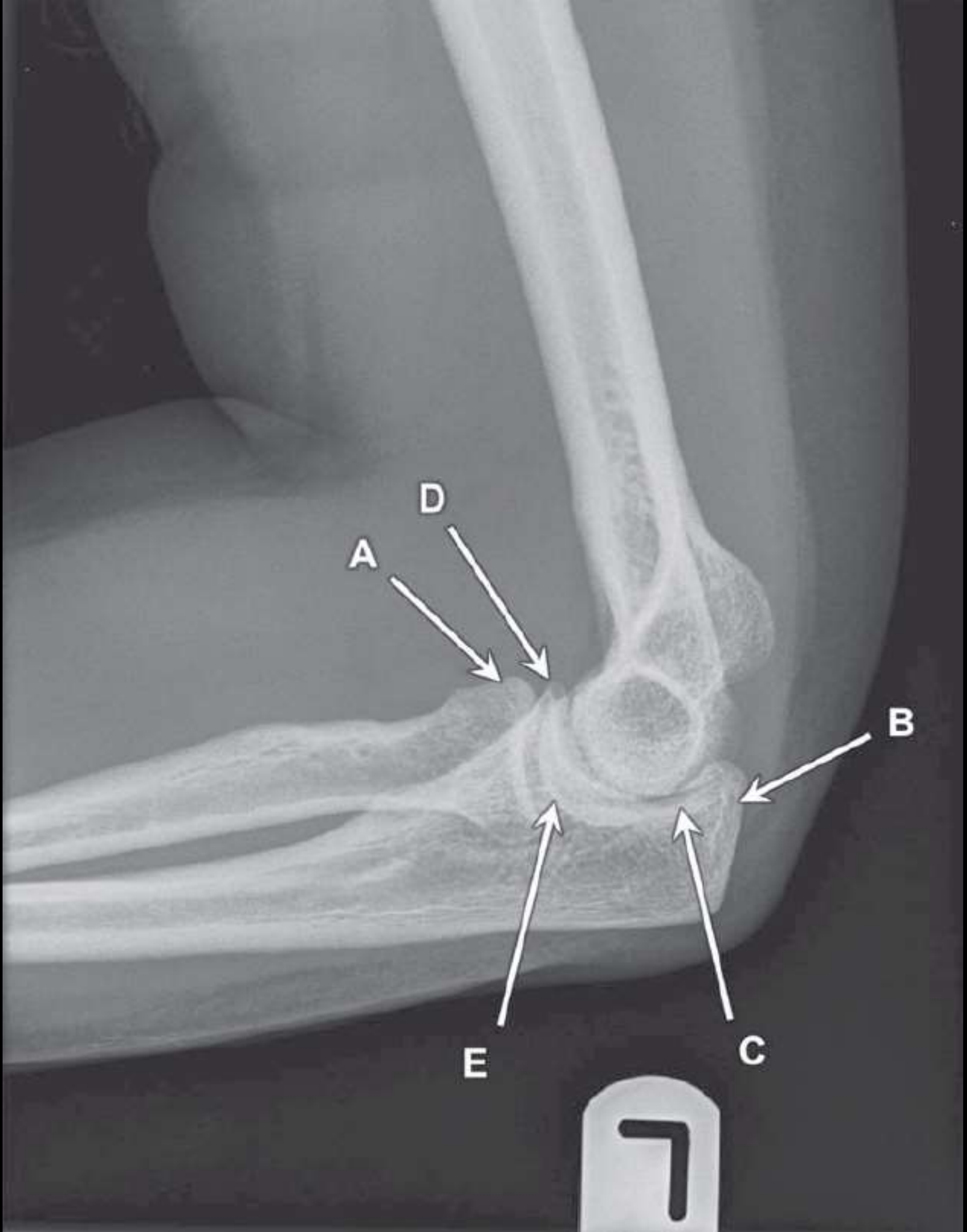
C Olecranon process

D Secondary ossification centre of the medial epicondyle

E Proximal radial metaphysis

Anteroposterior radiograph of the left elbow (child).

For further discussion see Chapter 4, Case 4.34.


D
A
B
E
C
L

Case 8

Plain radiograph. Lateral elbow.

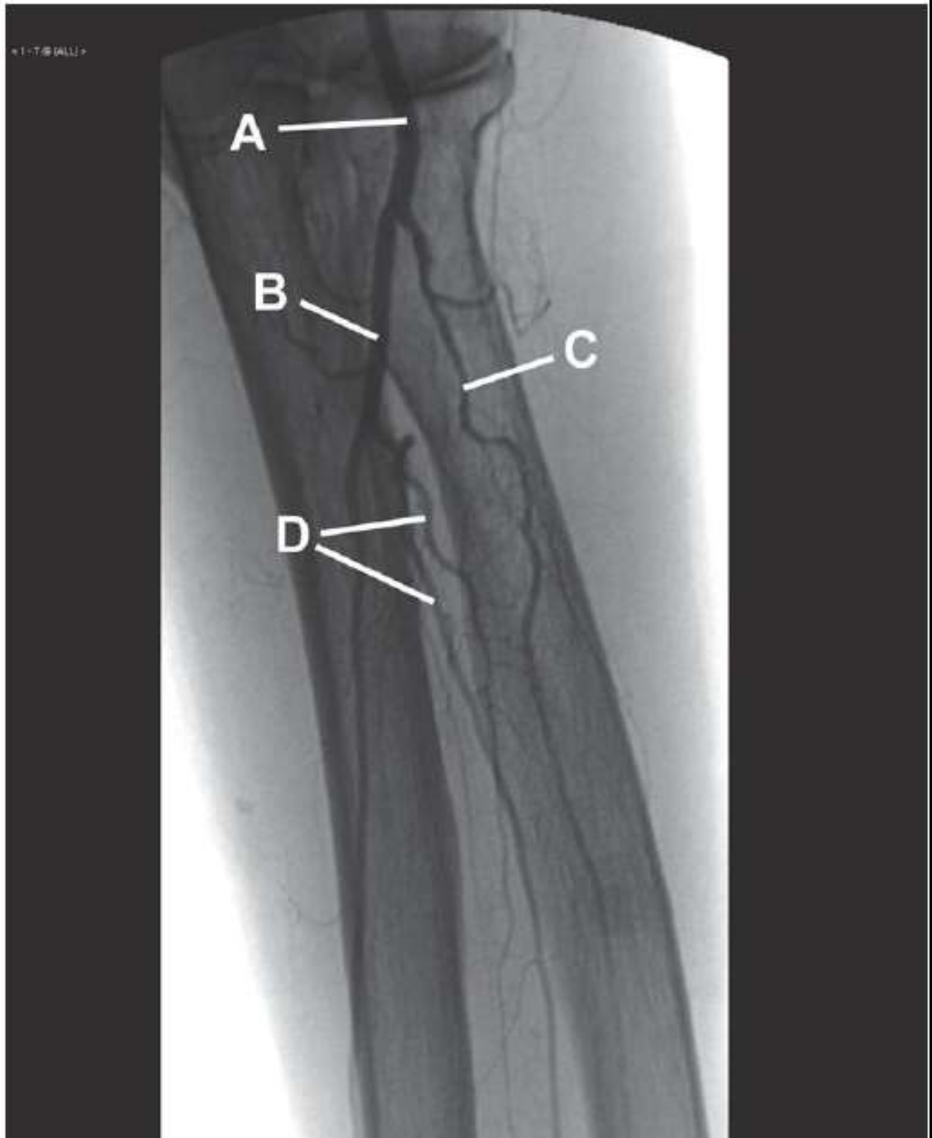
1. Head of radius
2. Olecranon of ulna
3. Trochlear notch of ulna
4. Coronoid process of ulna
5. Capitulum of humerus

Slightly tricky. Close inspection reveals that the structure labelled E is articulating with the radial head, so must be the capitulum of the humerus. The 'C' arrow, however points to the notch on the ulna.

ANGIO

Q13

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structures labelled D
e Name the structures that B and C terminate as in the hand

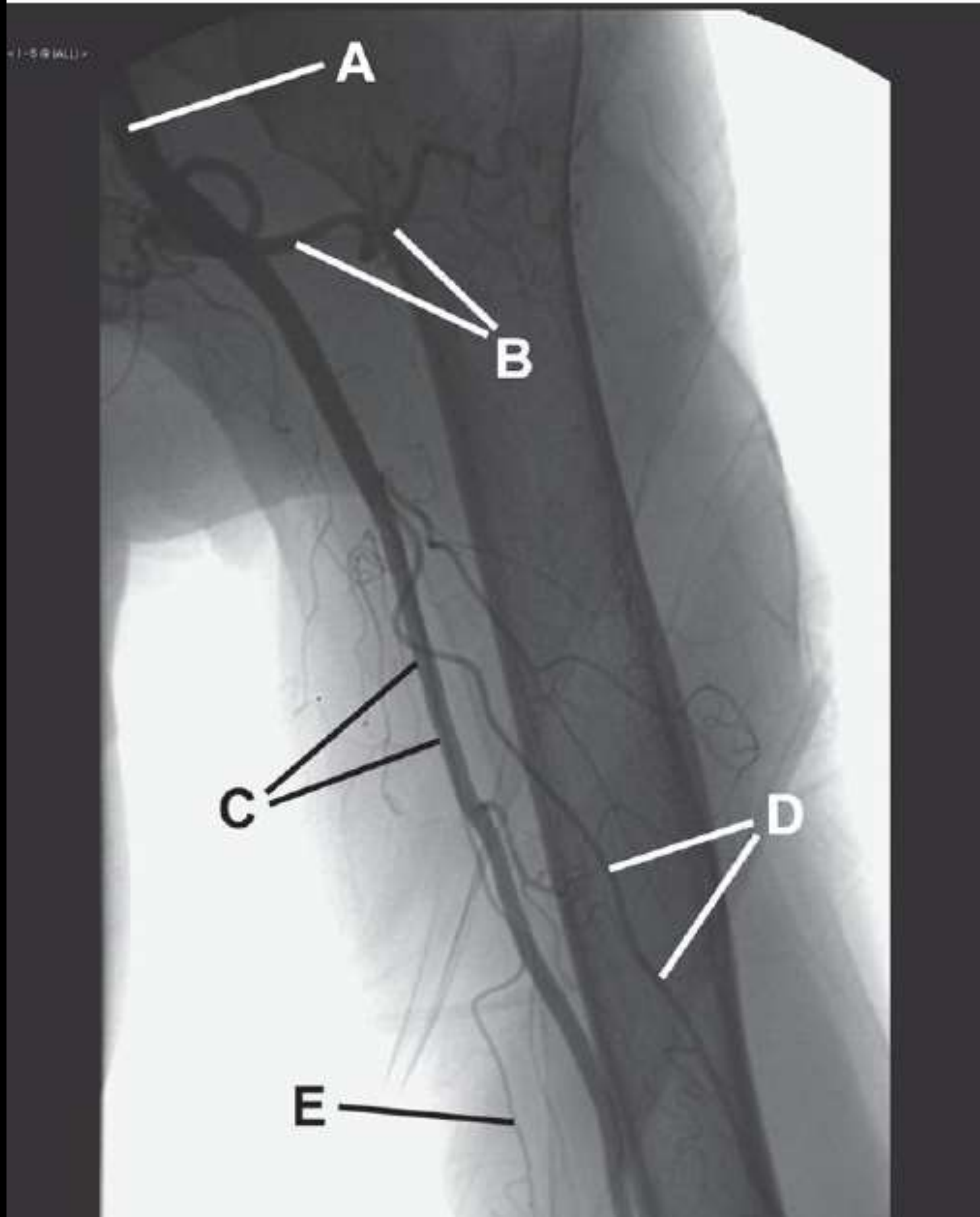


Q13 Answers

a Brachial artery
b Ulnar artery
c Radial artery
d Anterior and posterior interosseous arteries
e Superficial and deep palmar arches

Fluoroscopic angiogram of forearm, AP view

The brachial artery traverses the antecubital fossa to reach the upper forearm before dividing into its two terminal branches at the level of the radial neck. The radial artery runs laterally while the ulnar artery runs medially through the forearm. Just distal to its origin, the ulnar artery gives off the common interosseous artery which quickly divides into the anterior and posterior interosseous arteries. These arteries are so named because they travel along either side of the interosseous membrane which connects the adjacent internal surfaces of the bony radius and ulna. In the hand, the radial and ulnar arteries both contribute to anastomotic connections in the form of the superficial and deep palmar arches. By this means, the entire hand can potentially be supplied by either of these two major arteries.

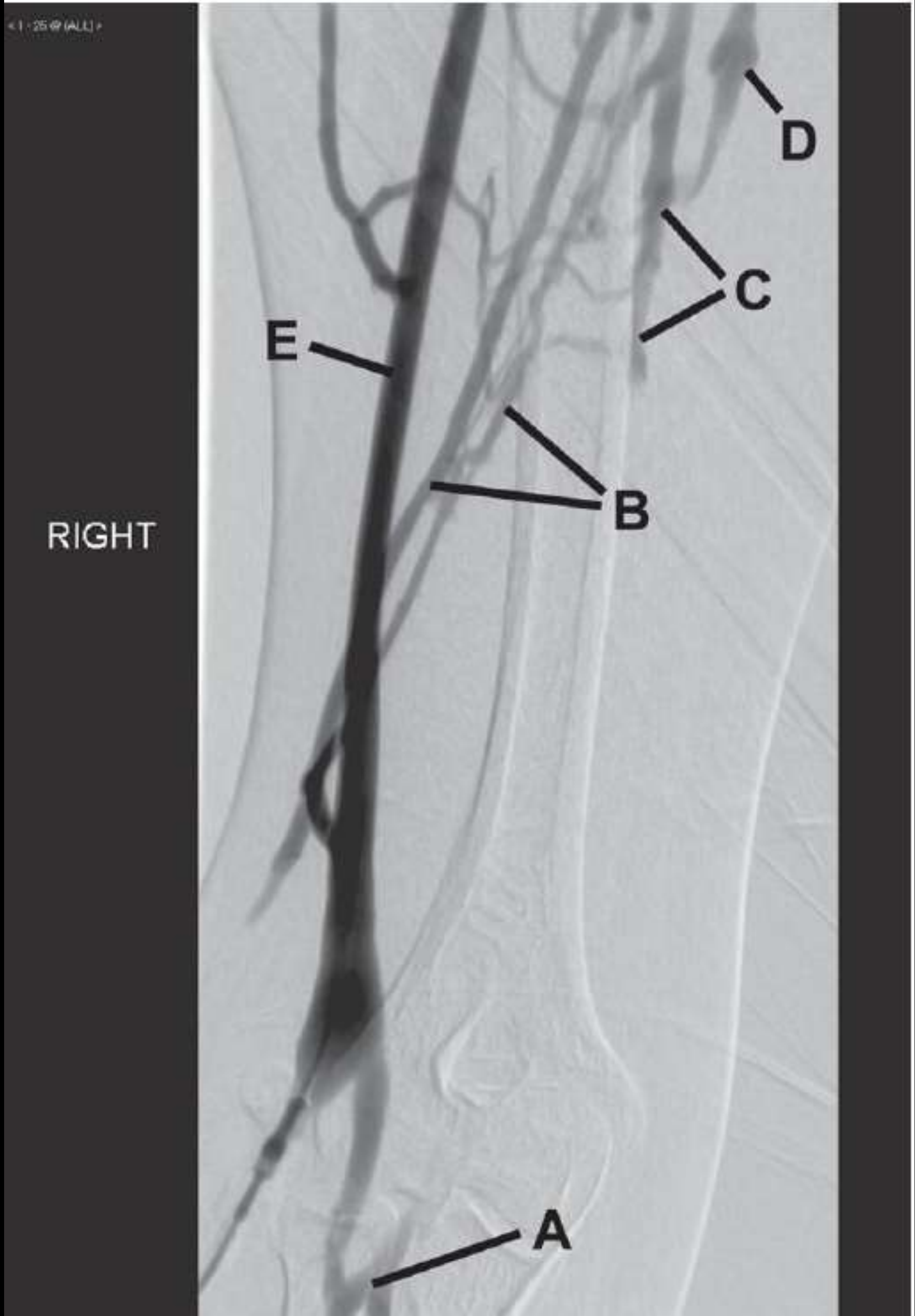

A
B
C
D
E

Q7 Answers

a Axillary artery
b Circumflex humeral artery
c Brachial artery
d Deep brachial artery (profunda brachii)
e Superior ulnar collateral artery

Fluoroscopic angiogram of the arm, AP view

Arterial blood to the upper limb is predominantly supplied by the axillary artery; numerous anastomoses exist around the scapula which can provide collateral supply in the event of axillary artery obstruction. At the lower border of the axilla (inferior border of teres major) the axillary artery becomes the brachial artery. The final branches of the axillary artery are the posterior and anterior circumflex humeral vessels; these arteries anastomose in a circle around the surgical neck of humerus. The brachial artery runs down the medial aspect of the arm and ends in the antecubital fossa where it bifurcates to form the radial and ulnar arteries. In addition to supplying the arm with arterial blood, several collateral vessels are derived from the brachial artery from different points along its course. These collaterals regroup around the elbow providing alternative blood supply to the forearm. The most notable include the deep brachial artery which follows the course of the radial nerve posteriorly behind the humerus and also the superior and inferior ulnar collateral arteries.



RIGHT
E
B
C
D
A

Q9 Answers

a Confluence of the radial and ulnar veins/origin of the brachial vein
b Deep brachial veins
c Brachial vein
d Venous valve
e Cephalic vein

Fluoroscopic venogram right arm, AP view

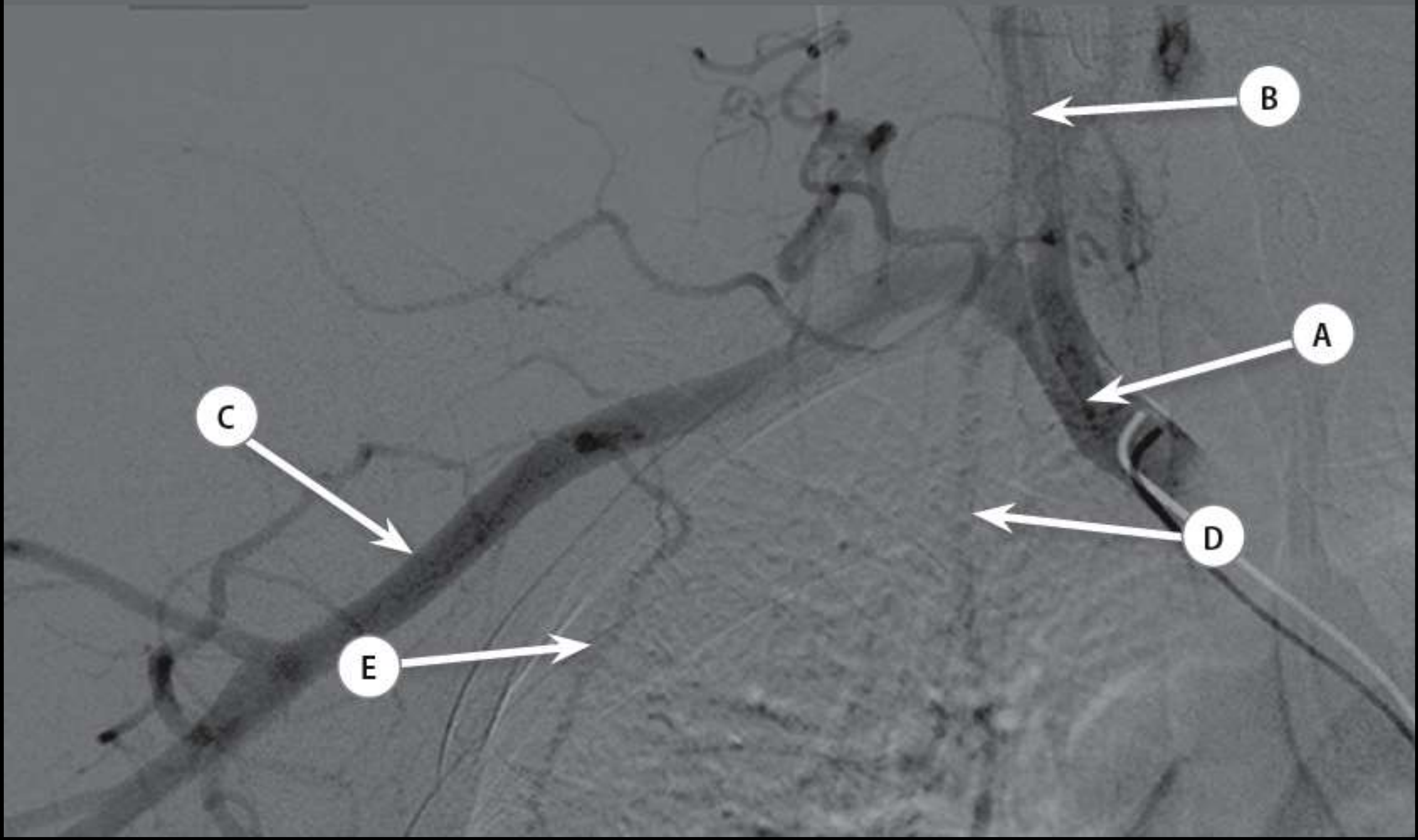
Venous drainage of the upper limb is divided into deep and superficial components.

The superficial veins are numerous and for the most part variable in their position. The cephalic and basilic veins are the major superficial veins of the arm and are more consistent in their path; they originate from a venous plexus on the dorsum of the hand and then travel up the medial (basilic) and lateral (cephalic) aspects of the arm. The superficial veins drain into the deep system via numerous perforating veins. Ultimately the basilic vein drains into the brachial vein in the upper arm while the cephalic vein drains more proximally into the axillary vein.

The deep veins of the arm are paired with the arteries both in name and with respect to the course they take.

Veins are recognizable on fluoroscopy by the existence of valves. These are periodically situated along the vessels and can be recognized as a short dilated segment; often the valve leaflets are seen within this segment (see image, labelled D).

Case 4.44



Case 4.44

A Right subclavian artery

B Right common carotid artery

C Right axillary artery

D Right superior (internal) thoracic artery

E Right lateral thoracic artery

Subclavian catheter angiogram.

The subclavian artery gives off six branches which supply the chest wall and the shoulder. The mnemonic SALSA is used to remember these branches:

S uperior thoracic artery (also called internal thoracic artery)

A cromiothoracic trunk

L ateral thoracic artery

S ubscapular artery

A nterior and posterior humeral artery

The subclavian artery becomes the axillary artery at the outer border of the first rib.

The arterial supply of the upper limb is summarised in **Figure 4.3.**

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 76.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 278.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 384.

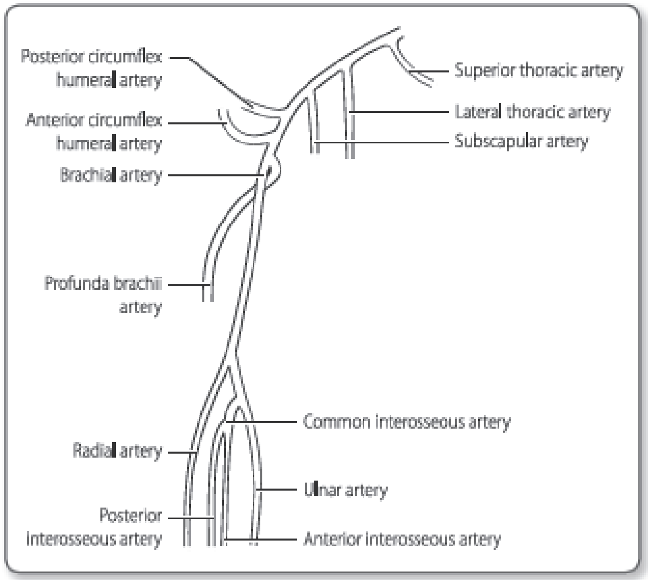
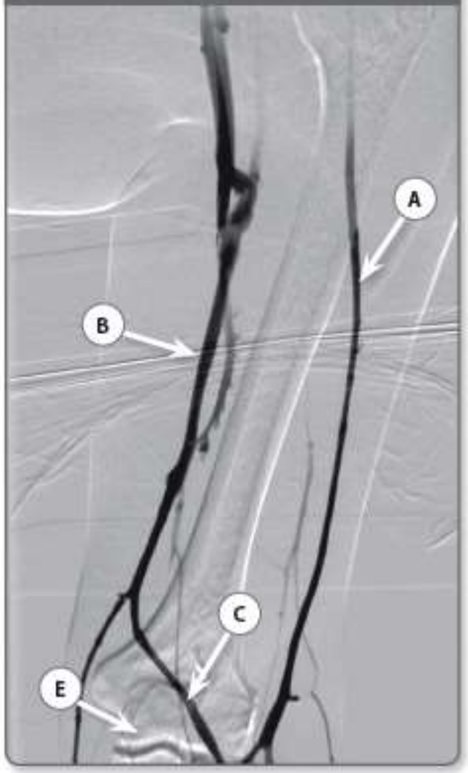


Figure 4.3 Arterial supply to the upper limb.

Case 6.11



Case 6.11

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	What vein is formed by the confluence of the brachial and basilic veins?	
E	Name the structure labelled E.	

Case 6.11

A Left cephalic vein

B Left basilic vein

C Left median antecubital vein

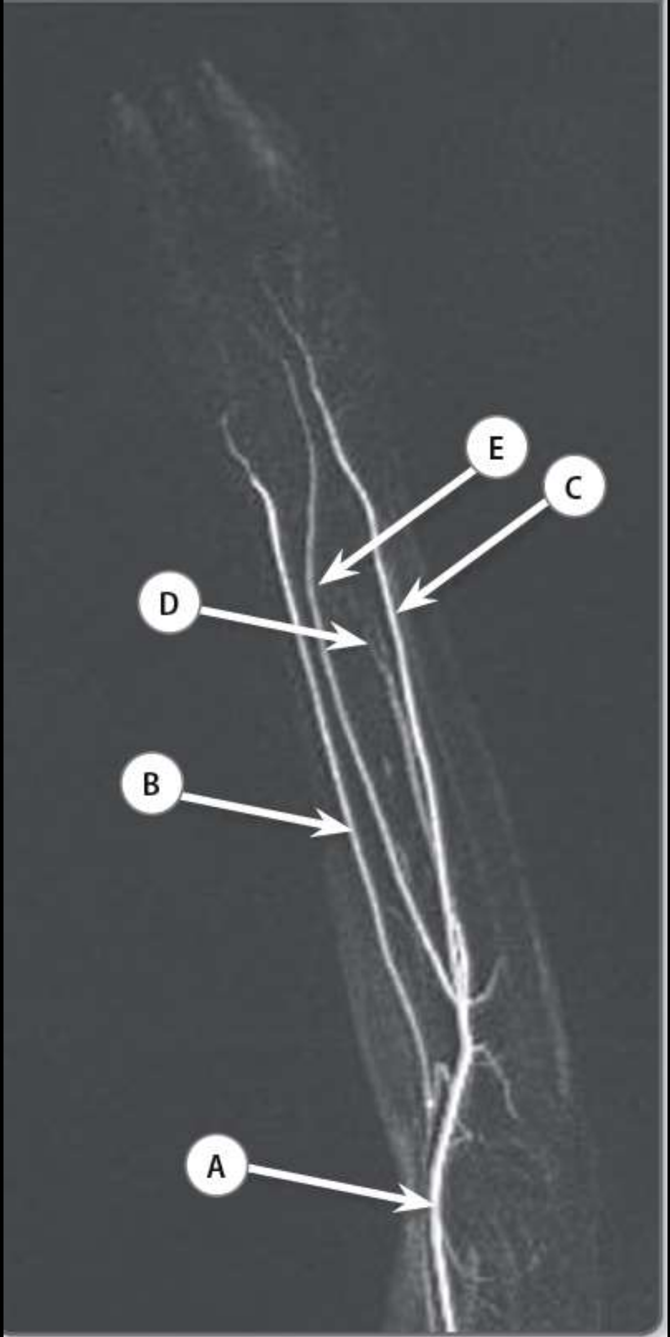
D Left axillary vein

E Trochlea of the left humerus

Venous anatomy of the upper limb is highly variable. The cephalic vein runs on the radial aspect of the forearm and the outer aspect of the arm and usually drains into the axillary vein at the level of the shoulder joint. The basilic vein runs on the medial aspect of the arm. The brachial veins lie adjacent to the brachial artery and drain into the axillary vein.

The medial antecubital vein in the anterior aspect of the elbow is commonly used for intravenous cannulation.

Case 4.45



Case 4.45

A Brachial artery

B Radial artery

C Ulnar artery

D Posterior interosseous artery

E Anterior interosseous artery

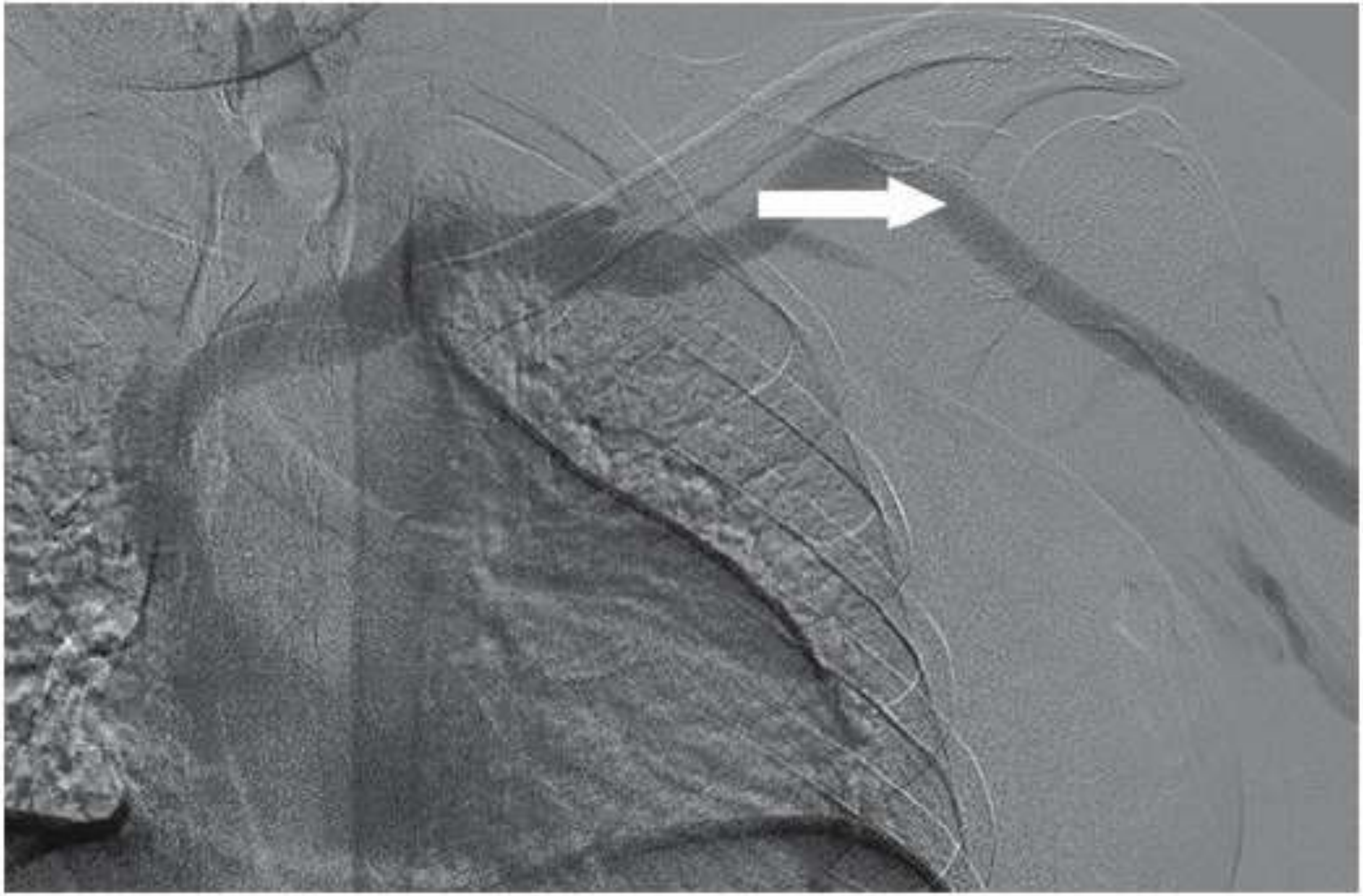
Brachial MR angiogram.

The brachial artery begins at the lower end of teres major. It gives off a profunda brachii which arises medially. It then gives off a nutrient artery to the humerus, muscular branches and branches to the elbow joint.

Within the antecubital fossa, approximately at the level of the radial head, the brachial artery divides into the radial and ulnar artery. The radial artery lies deep to brachioradialis. The ulnar artery is larger and deeper. It gives off the common intraosseous artery, which divides into the anterior and posterior intraosseous arteries.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 76.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 278.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 384.

Question 15:

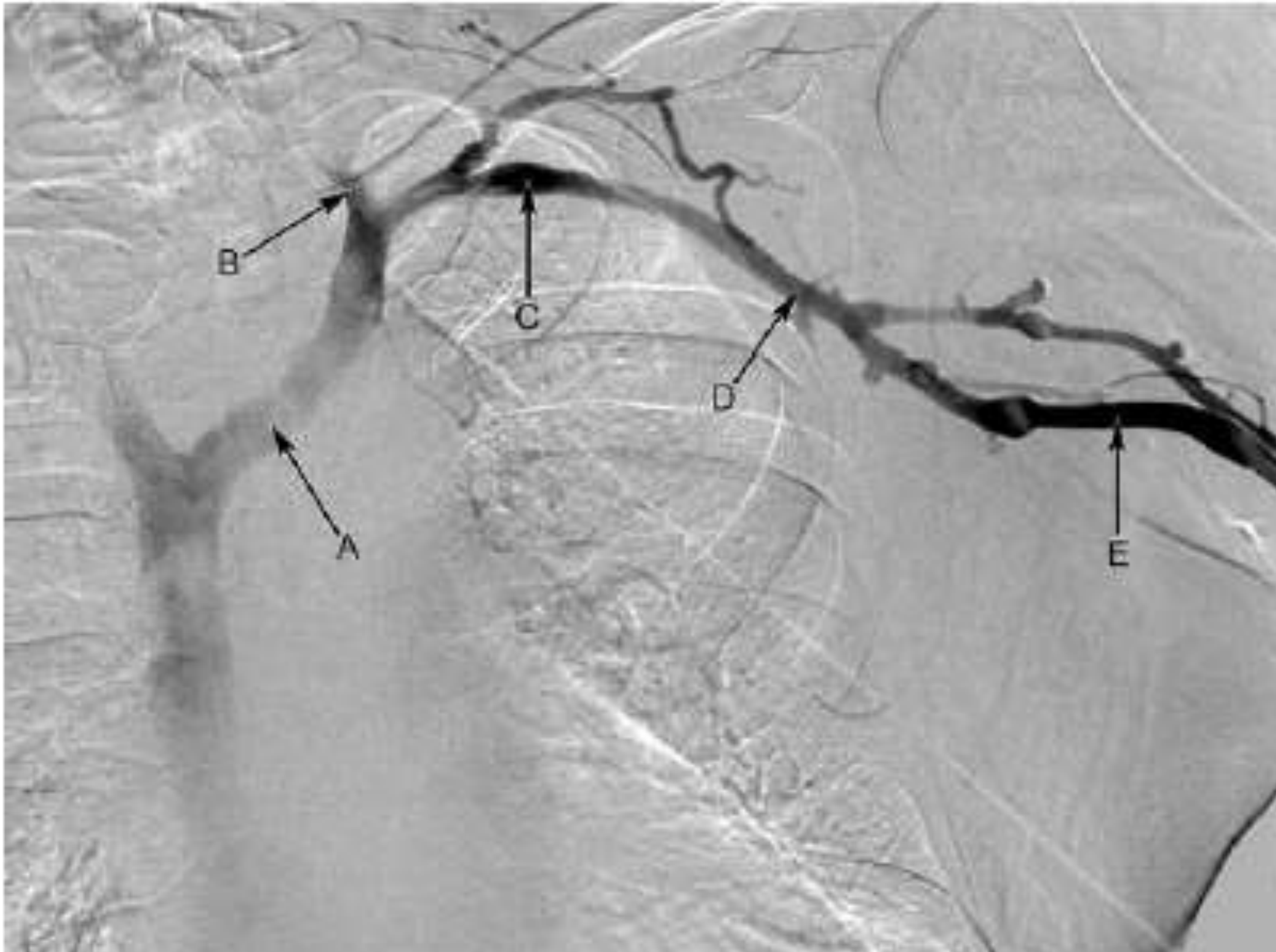


Question 15: Upper Limb venogram

Answer: Left axillary vein

- The axillary vein forms from the confluence of the brachial, basilic, and cephalic veins.
- It becomes the subclavian vein as it passes underneath the lateral border of the first rib.
- The cephalic vein originates from the confluence of the radial aspect of the dorsal venous plexus of the hand and ascends proximally up the forearm and arm. It pierces the clavipectoral fascia and drains into the axillary vein.
- The basilic vein originates from the confluence of the ulnar aspect of the dorsal venous plexus of the hand and ascends proximally up the forearm and forms the axillary vein.
- The basilic and cephalic veins communicate at the cubital fossa via the median cubital vein.

Question 10.4

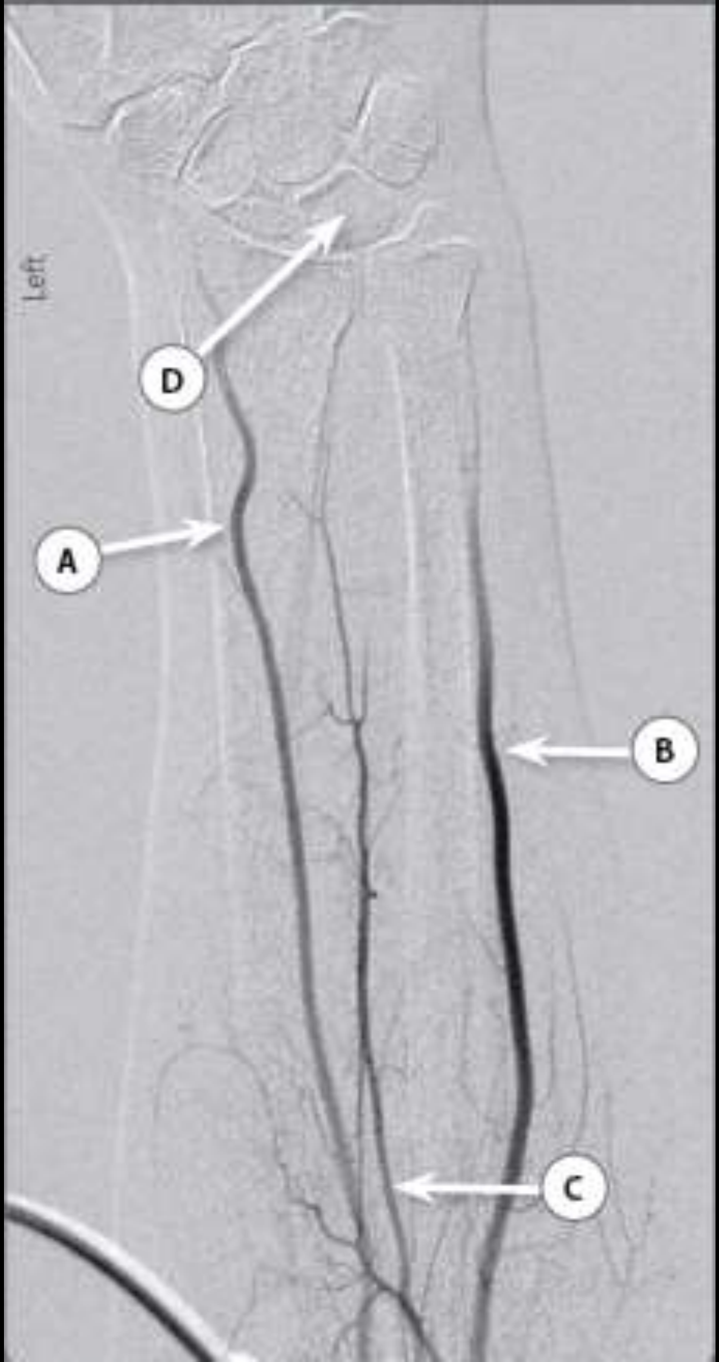


10.4 Venogram of the left arm

A Left brachiocephalic (innominate) vein.
B Left internal jugular vein.
C Left subclavian vein.
D Left axillary vein.
E Left basilic vein.

The brachial veins are paired deep veins, which ascend on either side of the brachial artery in the upper arm. At the level of the teres major they join to form the axillary vein, which then continues to the lateral border of the first rib. At this point the name changes to the subclavian vein. The subclavian vein continues to the level of the clavicular head where it joins with the internal jugular vein to form the brachiocephalic vein, which in turn joins with the contralateral brachiocephalic vein to form the superior vena cava.

Case 7.15



E	What artery divides into two major branches A and B at the level of the elbow?

Case 7.15

A Left radial artery

B Left ulnar artery

C Left interosseous artery

D Left lunate

E Left brachial artery

The brachial artery is the major arterial supply of the arm. This begins at the lower border of the teres major muscle and usually divides at the elbow into the radial and ulnar arteries. This bifurcation is highly variable and sometimes occurs in the upper arm.

The branches of the brachial artery are the profunda brachii, superior and inferior ulnar collateral arteries, nutrient artery to humerus and its terminal branches.

The interosseous artery is a branch of the ulnar artery and divides into anterior and posterior divisions.

CROSS-SECTIONAL

SHOULDER

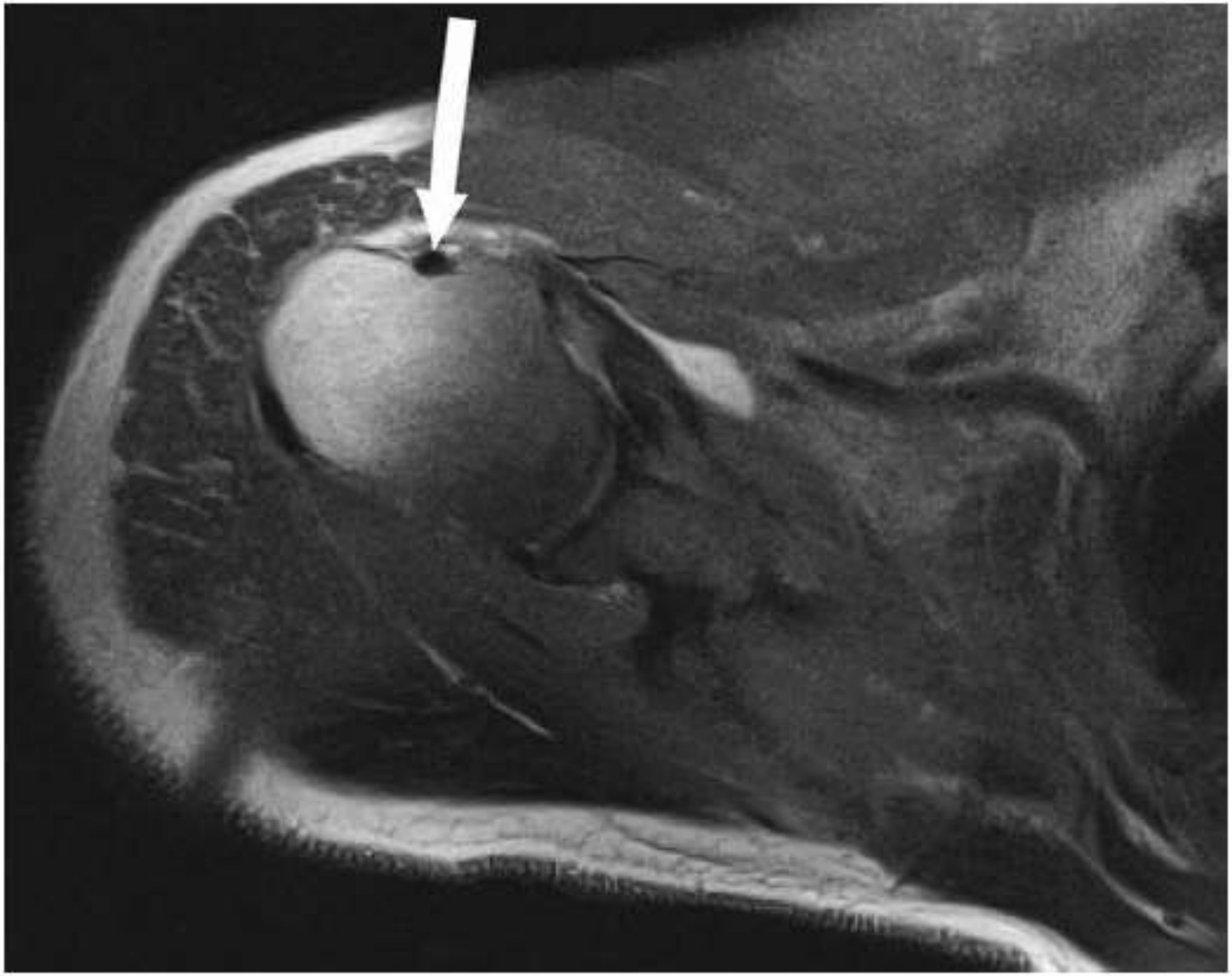
- Question 29:

Question 29: Coronal MRI of the right arm

Answer: Right deltoid muscle

- The deltoid muscle is a strong abductor of the arm, consisting of three major groups of fibres: anterior, lateral, and posterior.
- The anterior fibres arise from the anterior border of the clavicle. The lateral fibres arise from the acromion process and the posterior fibres arise from the posterior aspect of the scapular spine.
- The deltoid fibres are distinctive in their strong but short, broad fibres, and the muscle is easily identifiable on CT reformats and MRI sequences. They insert at the deltoid tuberosity on the medial aspect of the humeral shaft.

Question 12:

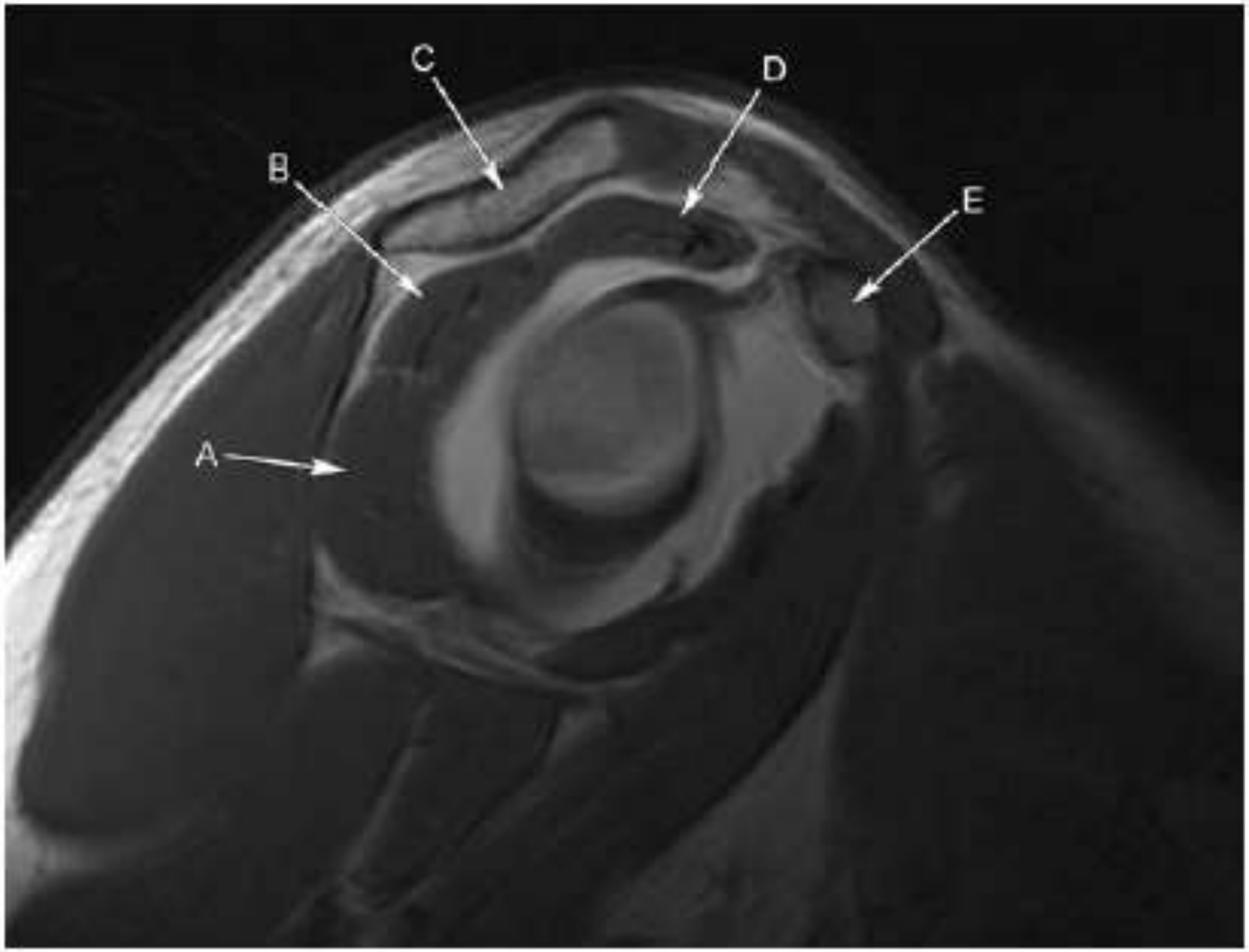


Question 12: Axial MRI of the shoulder

Answer: Biceps brachii muscle tendon (long head)

- As its name infers, the biceps brachii ('two headed muscle of the arm') muscle is formed by two proximal muscle bundles: the short head originating from the coracoid process of the scapula, and the long head from the supraglenoid tubercle.
- The long head has a tendon that passes within the bicipital groove (intertubercular groove) of the humerus.
- The heads join at mid humeral level to form a common muscle belly before inserting into the radial tuberosity.

Question 1.18 This is an oblique sagittal MRI of the shoulder.



Name the structures labelled **A** to **E**.

1.18 Sagittal MRI T1 arthrogram of the right shoulder

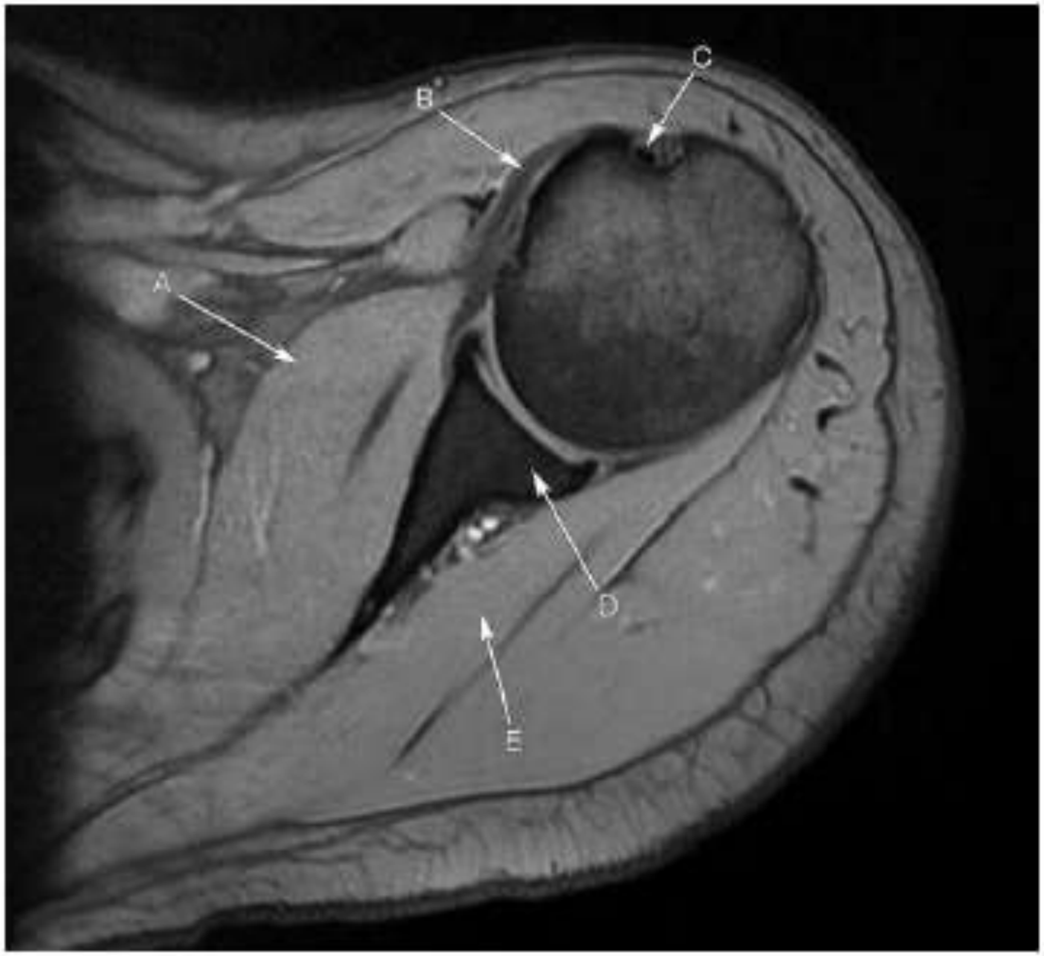
A Right teres minor muscle.
B Right infraspinatus muscle.
C Right acromion.
D Right supraspinatus muscle.
E Right coracoid process.

Stability of the hip is provided mainly by the bony acetabulum. Stability of the shoulder is provided by a group of four muscles that together form the rotator cuff. The muscles of the rotator cuff can be remembered using the mnemonic **SITS**:

- **S**upraspinatous.
- **I**nfraspinatous.
- **T**eres minor.
- **S**ubscapularis.

The teres minor and infraspinatus are external rotators of the shoulder. The teres minor originates from the dorsal surface of the axillary border of the scapula and inserts onto the greater tuberosity of the shoulder. The infraspinatus originates from the infraspinous fossa of the scapula and is also attached to the greater tuberosity of the shoulder. The acromion is the distal continuation of the spine of the scapula, extends laterally over the shoulder joint and articulates with the clavicle to form the acromioclavicular joint. The supraspinatus initiates abduction of the shoulder and originates from the supraspinatus fossa of the scapula, passing immediately inferior to the acromion and inserting into the greater tuberosity of the humerus. The coracoid is a bony anterior eminence of the scapula and provides a useful landmark for identifying the anterior structures when assessing sagittal cross-sectional imaging of the shoulder. If the coracoid is on your **RIGHT** as you look at the image on a sagittal section of the shoulder then you are looking at the **RIGHT** shoulder.

Question 4.8



This is an axial MRI of the shoulder.
Name the structures labelled **A** to **E**.

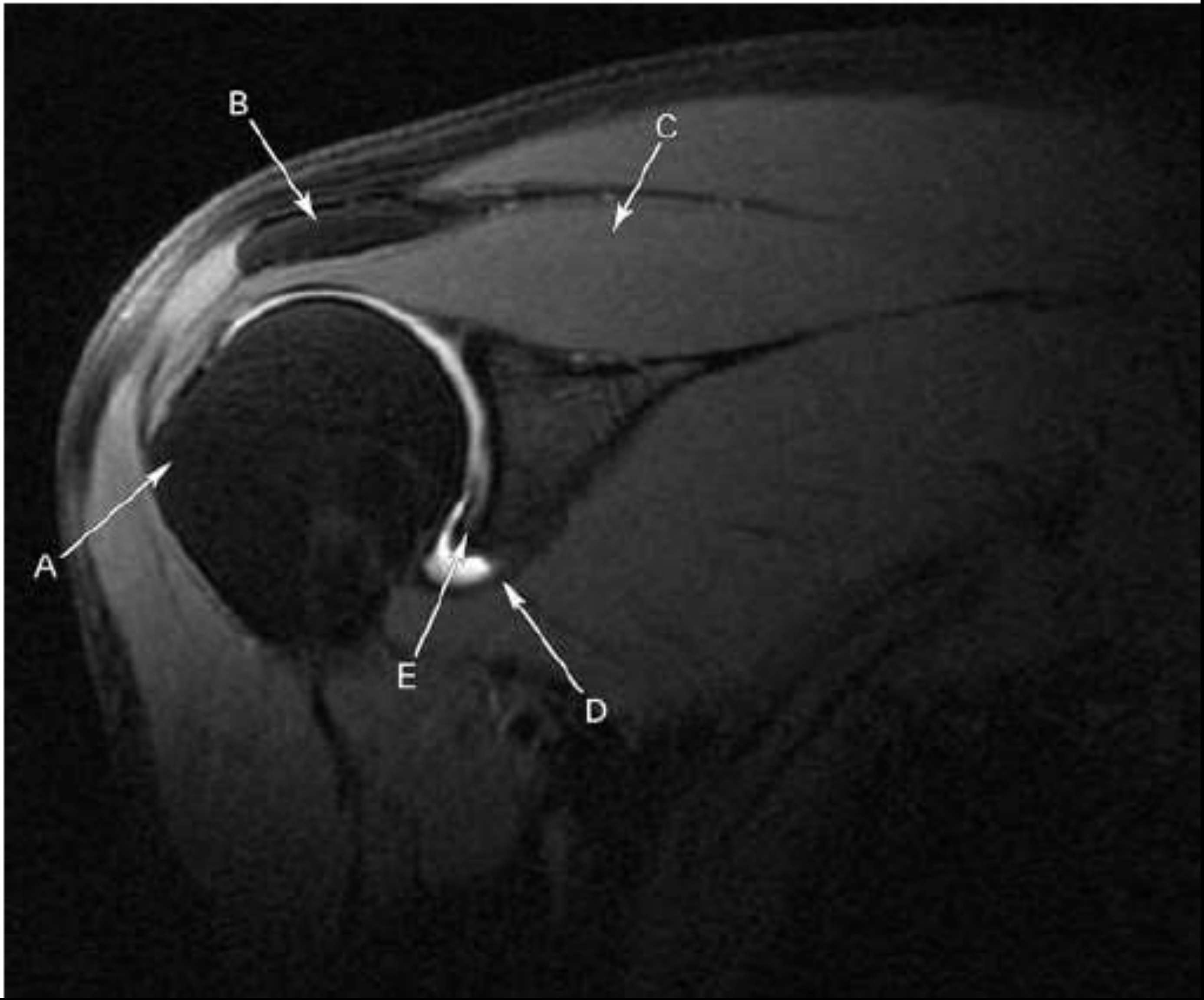
4.8 Axial proton density MRI of the left shoulder

A Left subscapularis muscle.
B Left subscapularis tendon.
C Left biceps brachii tendon.
D Left glenoid.
E Left infraspinatus muscle.

Biceps brachii literally translated in Latin means 'two headed of the arm', meaning that the muscle is composed of two muscles with separate origins but which share a common insertion (the radial tuberosity). The short head of the biceps attaches to the coracoid process of the scapula whereas the long head travels, as demonstrated within this image, within the intertubercular groove of the humerus through the joint capsule to insert to the supraglenoid tubercle of the scapula.

A joint capsule is the envelope surrounding a synovial joint. The shoulder capsule completely surrounds the shoulder attaching around the glenoid of the scapula beyond the glenoid labrum (the cartilaginous layer). Laterally, the capsule attaches to the anatomical neck of the humerus.

Question 5.8



5.8 Coronal MR arthrogram of the right shoulder

A Right greater tuberosity of the humerus.
B Right acromion.
C Right supraspinatus muscle.
D Right joint capsule.
E Right inferior glenoid labrum.

The supraspinatus initiates abduction of the shoulder and originates from the supraspinatus fossa of the scapula. This image demonstrates its passage immediately inferior to the acromion and its insertion onto the greater tubercle of the humerus. The space between the humeral head and the acromion is called the subacromial space; when it is narrowed the tendon of the supraspinatus is at risk of a tear. Of the rotator cuff muscles, the supraspinatus is most commonly torn (with its insertion at the greater tuberosity being the most common location). The inferior glenoid labrum is another important review area landmark when assessing shoulder MRI. The anterior inferior glenoid labrum is susceptible to injury following anterior shoulder dislocation (termed a Bankart lesion). This is often accompanied by a fracture of the posterior humeral head (termed a Hill–Sachs lesion).

Question 7.16

7.16 Axial CT of the shoulder

A Right deltoid muscle.
B Right pectoralis minor muscle.
C Right pectoralis major muscle.
D Right humerus.
E Right triceps muscle.

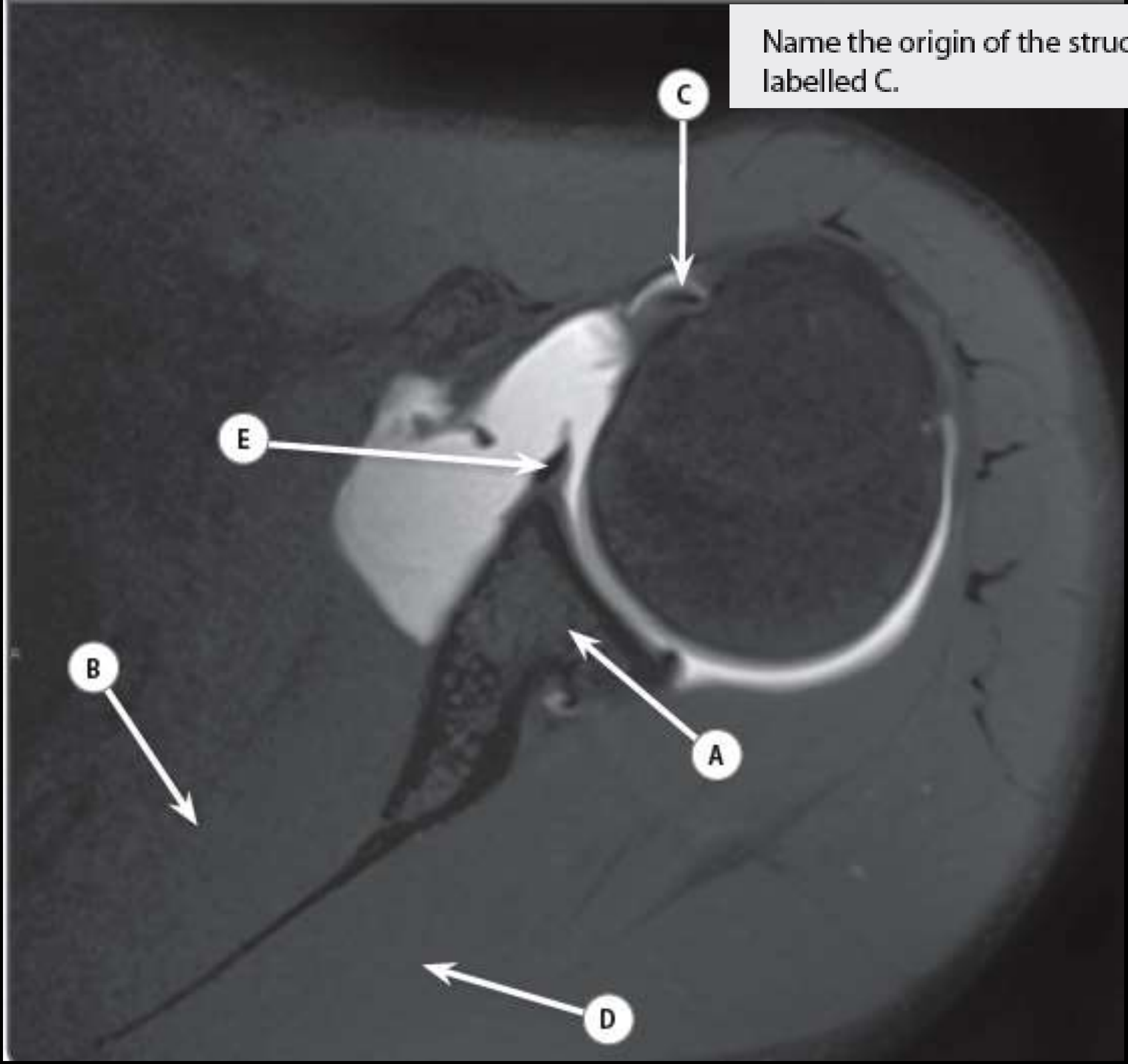
The deltoid is the outermost muscle of the shoulder and is innervated by the axillary nerve. It is an abductor of the arm in the scapula plane.

The pectoralis major lies anterior to the pectoralis minor and arises from the medial half of the clavicle, the sternum and the cartilage of the true ribs. The fibres converge to join as a tendon attaching to the lateral lip of the bicipital groove of the humerus. The pectoralis major is innervated by the medial and lateral pectoral nerves.

The pectoralis minor arises from the third to the fifth ribs and inserts into the coracoid process of the scapula. It is innervated by the medial pectoral nerve. The triceps muscle has three heads – medial, lateral and long heads. The long head arises from the infraglenoid surface of the scapula. The medial and lateral heads insert to the dorsal aspect of the humerus.

Case 3.5

Name the origin of the structure labelled C.



Case 3.5

A Glenoid of scapula

B Subscapularis muscle

C Superior glenoid tubercle

D Infraspinatus muscle

E Anterior glenoid labrum

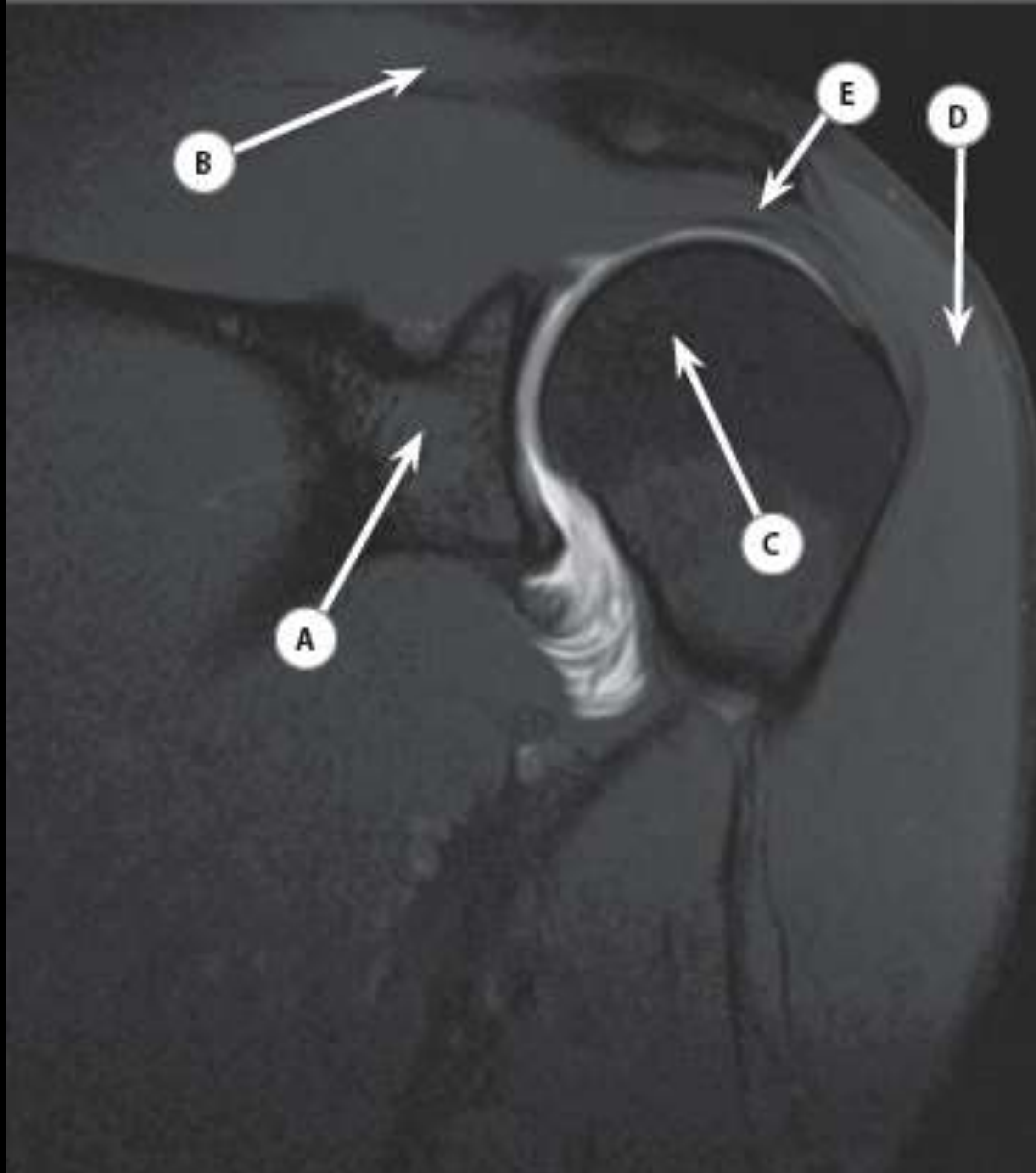
The rotator cuff is composed of four muscles and their respective tendons. Its function is to stabilise the glenohumeral joint during dynamic activity.

The following muscles make up the rotator cuff:

1. Supraspinatus:
   - Origin – supraspinatus fossa of scapula (dorsal, superior to the spine of scapula)
   - Insertion – superior part of the greater tuberosity of ipsilateral humerus
2. Infraspinatus:
   - Origin – infraspinatus fossa of scapula (dorsal, inferior to the spine of scapula)
   - Insertion – middle part of the greater tuberosity of ipsilateral humerus
3. Subscapularis:
   - Origin – subscapular fossa of scapula (ventral surface of body of scapula)
   - Insertion – lesser tuberosity of ipsilateral humerus
4. Teres minor:
   - Origin – lateral scapular angle
   - Insertion – inferior part of the greater tuberosity of ipsilateral humerus

The long head of biceps brachii muscle originates from the supraglenoid tubercle.

Case 8.7



Case 8.7

- **A** Glenoid of shoulder
- **B** Trapezius muscle
- **C** Head of humerus
- **D** Deltoid muscle
- **E** Supraspinatus muscle (musculotendinous portion)

MRI of the shoulder is a common examination to assess for rotator cuff tears or impingement. Supraspinatus is the most common muscle involved in these pathologies and this MRI nicely demonstrates the relatively narrow subacromial space. Impingement occurs if:

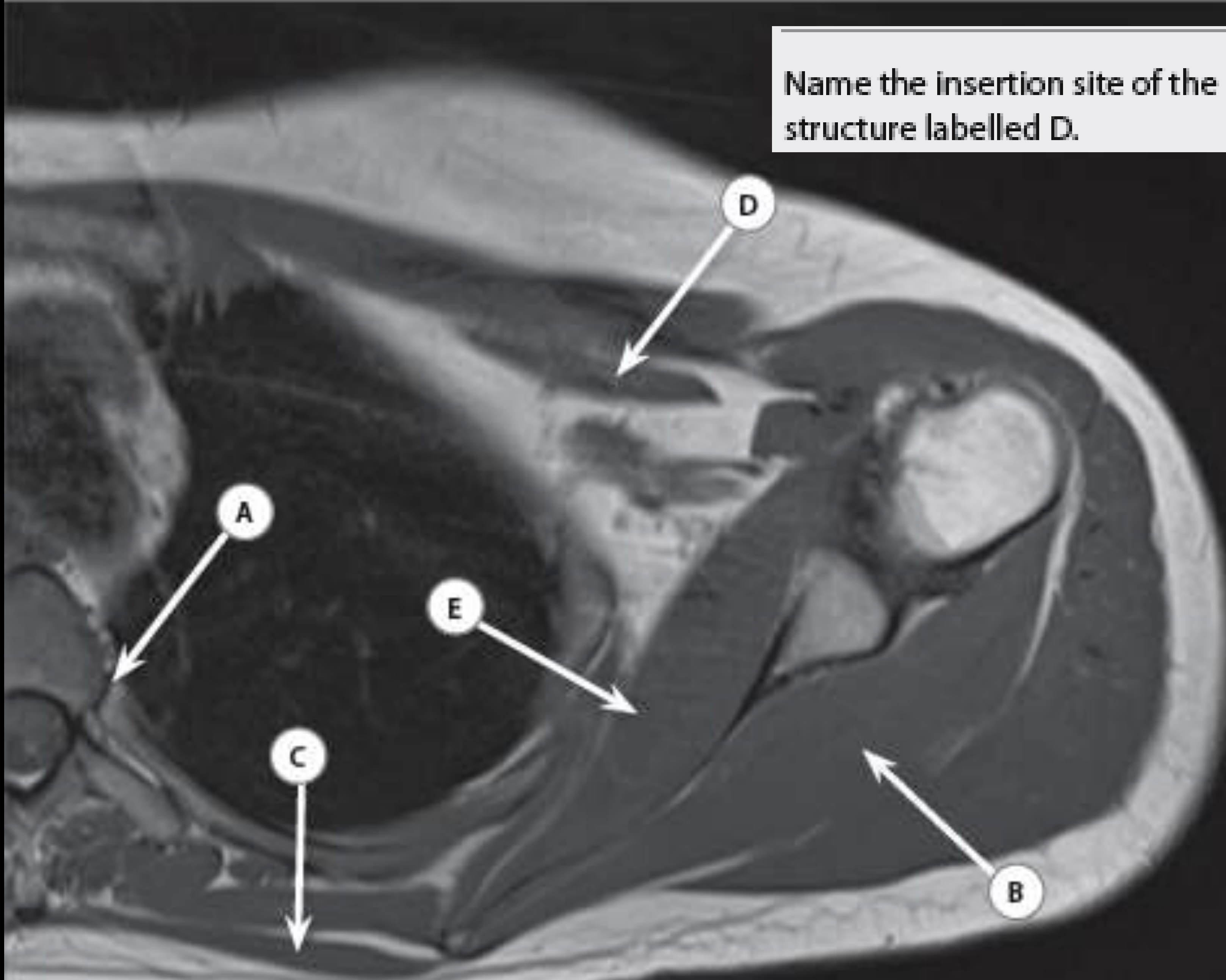
- the subacromial space becomes further narrowed
- there is enlargement of the supraspinatus muscle.

The clavicle may be used as a horizontal margin to differentiate between the trapezius and deltoid muscles on shoulder MRI:

- trapezius lies superior to the clavicle
- deltoid is inferior to the clavicle.

Case 10.16

Name the insertion site of the structure labelled D.



Case 10.16

A Left costovertebral joint

B Left infraspinatus muscle

C Left trapezius muscle

D Left coracoid process

E Left subscapularis muscle

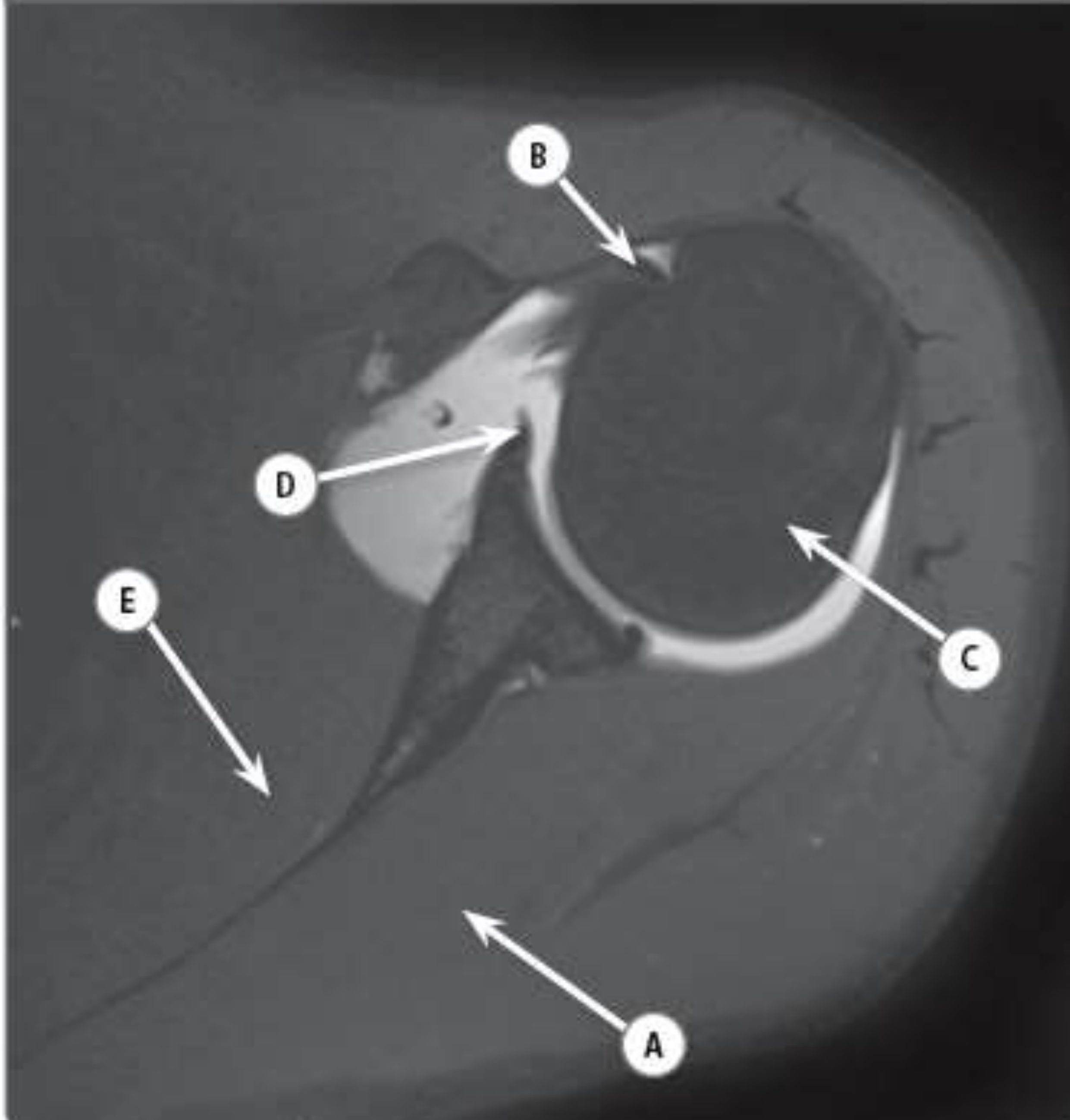
There are two posterior articulations between the ribs and vertebrae:

1. costovertebral joint (A)
2. costotransverse joint

Pectoralis minor inserts into the coracoid process of the scapula, which also serves as the origin for the short head of biceps brachii and coracobrachialis.

The dorsal fossae of the scapula are the sites of origin for the supra- and infraspinatus whilst the ventral subscapular fossa serves as the origin for the subscapularis.

Case 11.15

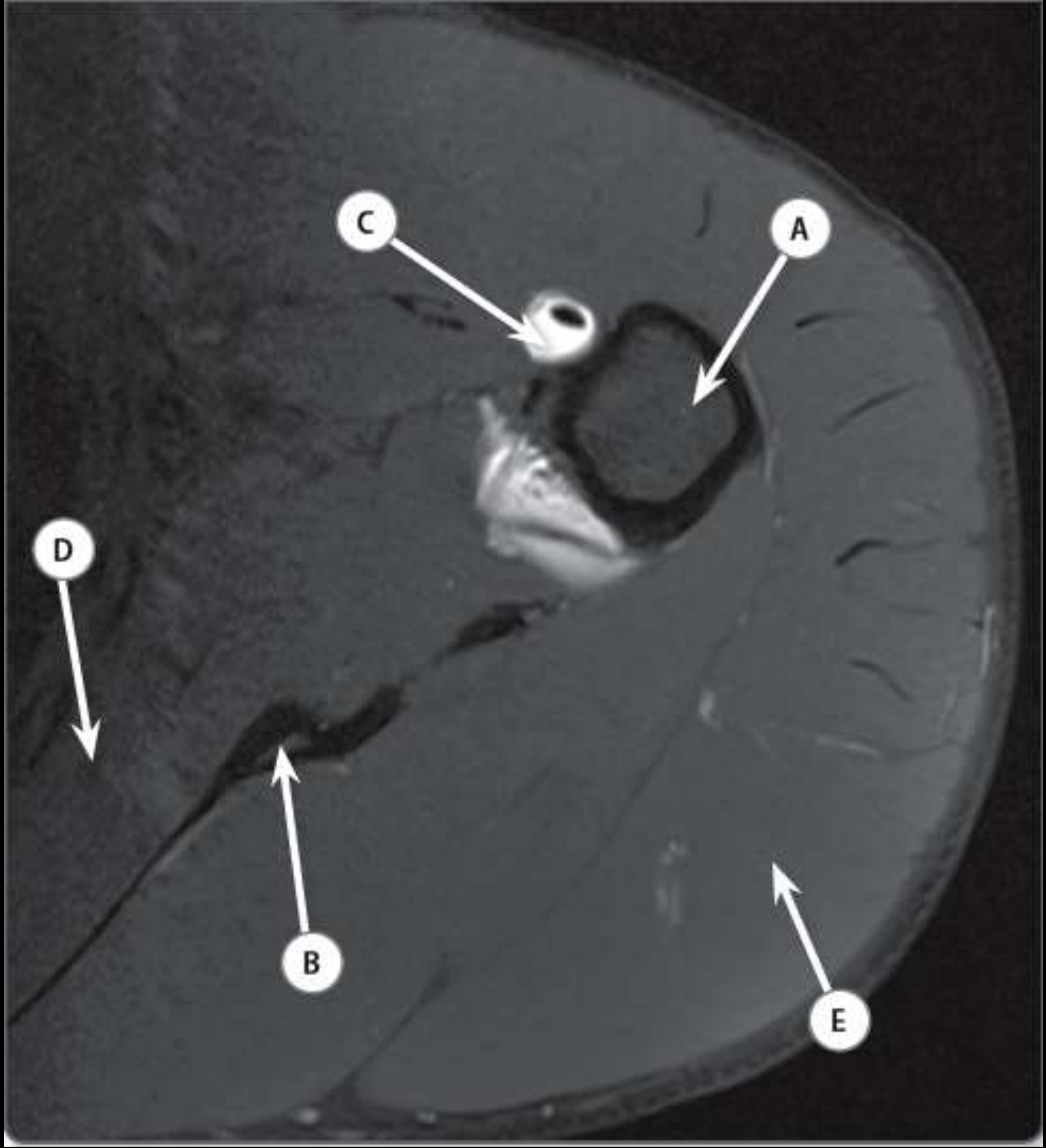


Case 11.15

- **A** Infraspinatus muscle
- **B** Long head of biceps brachii tendon
- **C** Head of humerus
- **D** Anterior glenoid labrum
- **E** Subscapularis muscle

The long head of biceps tendon originates from the supraglenoid tubercle of the scapula and courses down the proximal humerus in the bicipital groove. The subscapularis muscle lies deep to the body of the scapula whereas the infraspinatus muscle lies superficially.

Case 13.3



Case 13.3

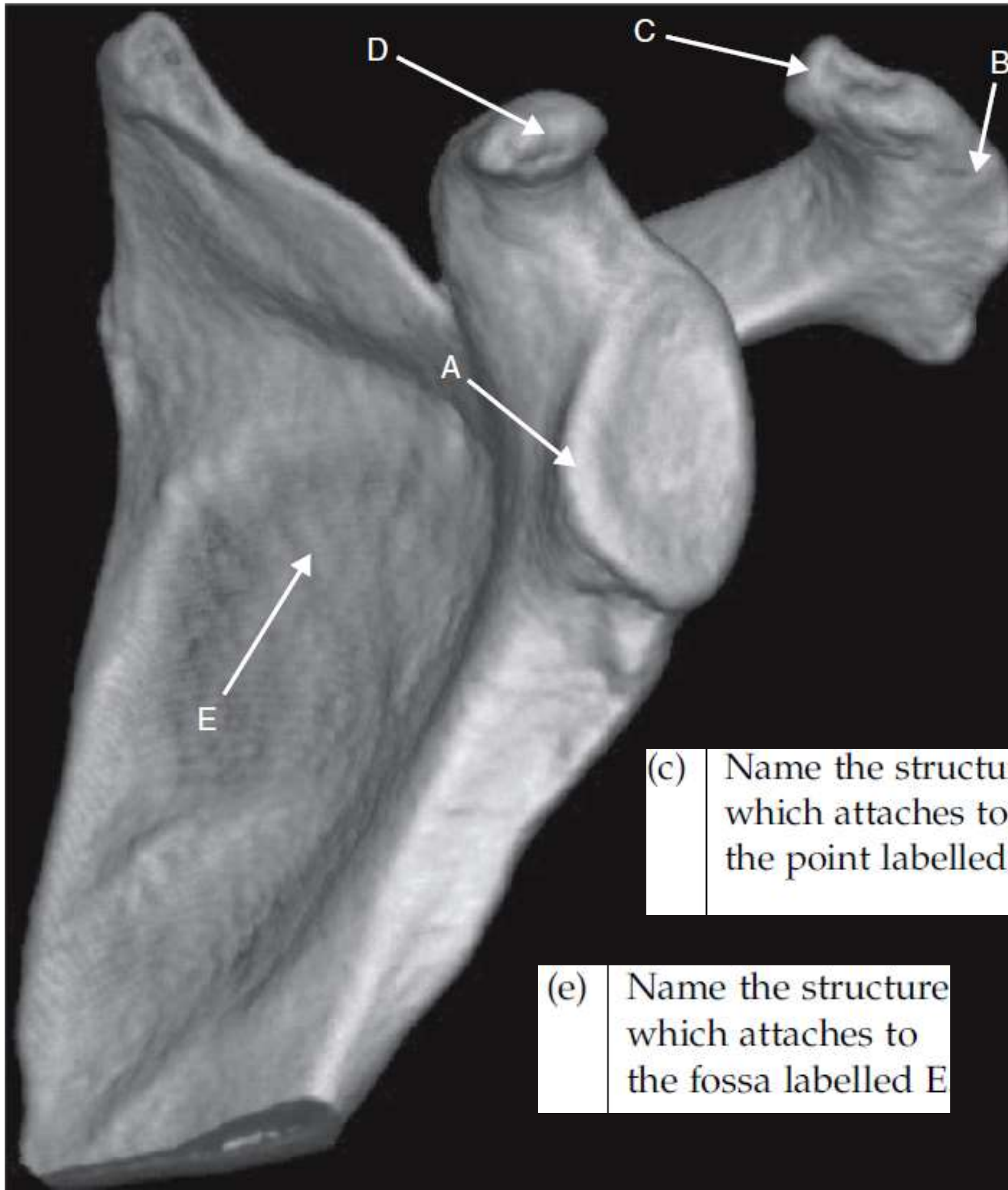
- A Proximal humerus
- B Body of scapula
- C Long head of biceps brachii tendon sheath
- D Subscapularis muscle
- E Deltoid muscle

The long head of biceps brachii originates from the supraglenoid tubercle (as a tendon) and is enclosed by a sheath which is continuous with the glenohumeral joint – hence contrast is visualised within the sheath outlining the (black) tendon. The tendon lies within the bicipital groove of the most proximal humerus, which is an osseous sulcus created by the lesser and greater tuberosities of the humerus.

Deltoid is seen to lie superficial to the rotator cuff and inferior to the horizontal margin of the clavicle. Trapezius is superior to the clavicle.

Subscapularis originates from the subscapular fossa on the deep/ventral surface of the scapula.

Case 8.12



(c)	Name the structure which attaches to the point labelled C.

(e)	Name the structure which attaches to the fossa labelled E

8.12 3D volume rendering of the scapula

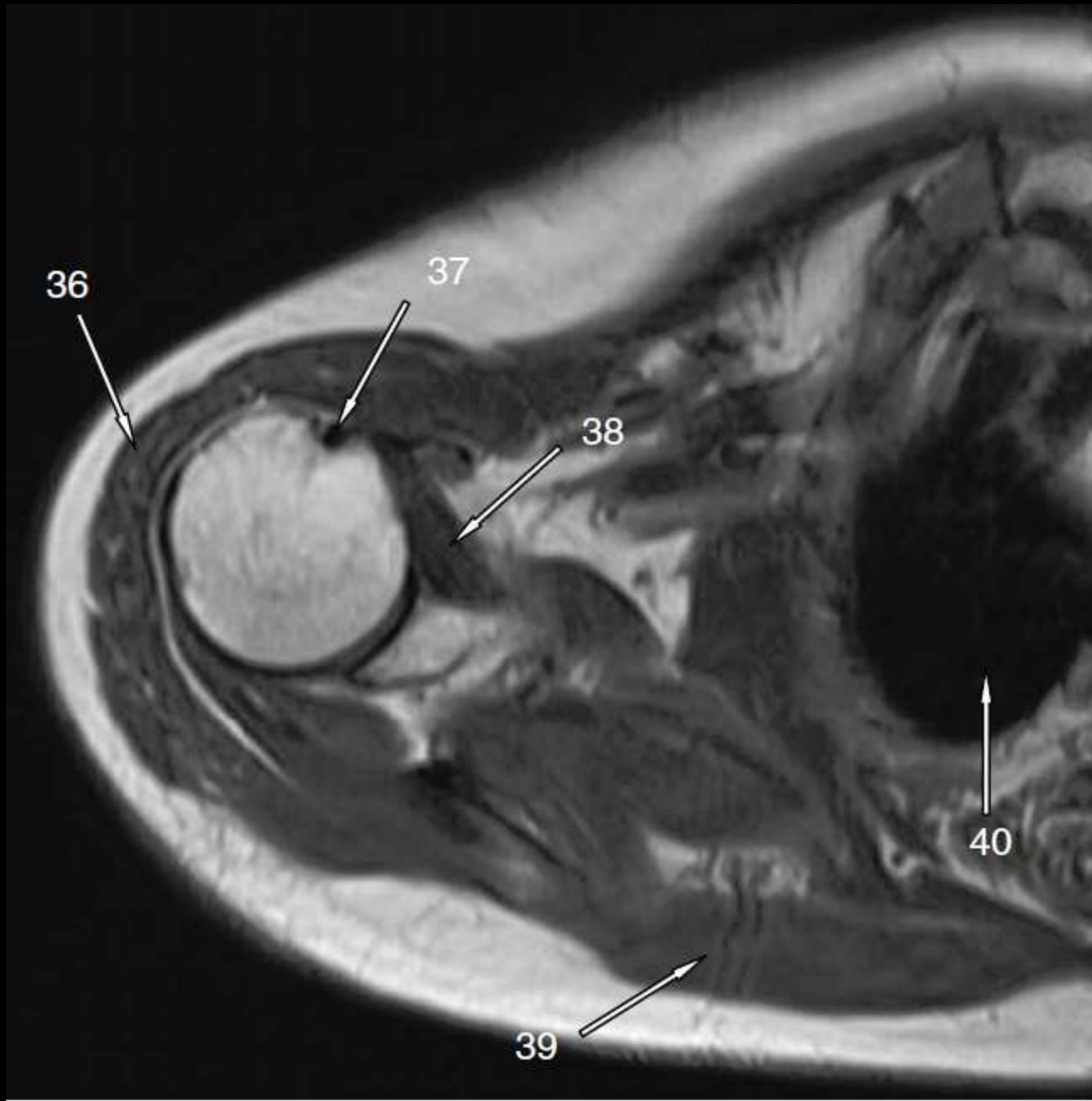
(a) Antero-inferior glenoid rim. This is an important region as it bears the attachment of the anterior band of the inferior glenohumeral ligament (AIGHL). This is the site of avulsion fracture sustained during anterior glenohumeral dislocation known as a bony Bankart lesion. The classic Bankart lesion refers to avulsion of the antero-inferior glenoid labrum along with the AIGHL and thus cannot be seen on radiographs.

(b) Acromion process. The deltoid origin is broad and curved and extends around the entire border of the acromion. Bony avulsion of the acromion is rare following trauma though enthesopathy at the deltoid origin is a common degenerative feature on radiographs.

(c) Coraco-acromial ligament (CAL). The CAL is a narrow but tough ligament that arises from the anterior tip of the acromial undersurface. Its origin may form a bony enthesophyte that has been implicated in the aetiology of supraspinatus tendon tears. The CAL is thought to contribute to the clinical condition of sub-acromial impingement and it is routinely divided during a sub-acromial decompression procedure.

(d) Coracoid process. The coracobrachialis is a long muscle that arises from the coracoid process and inserts distally on the antero-medial surface of the humeral diaphysis.

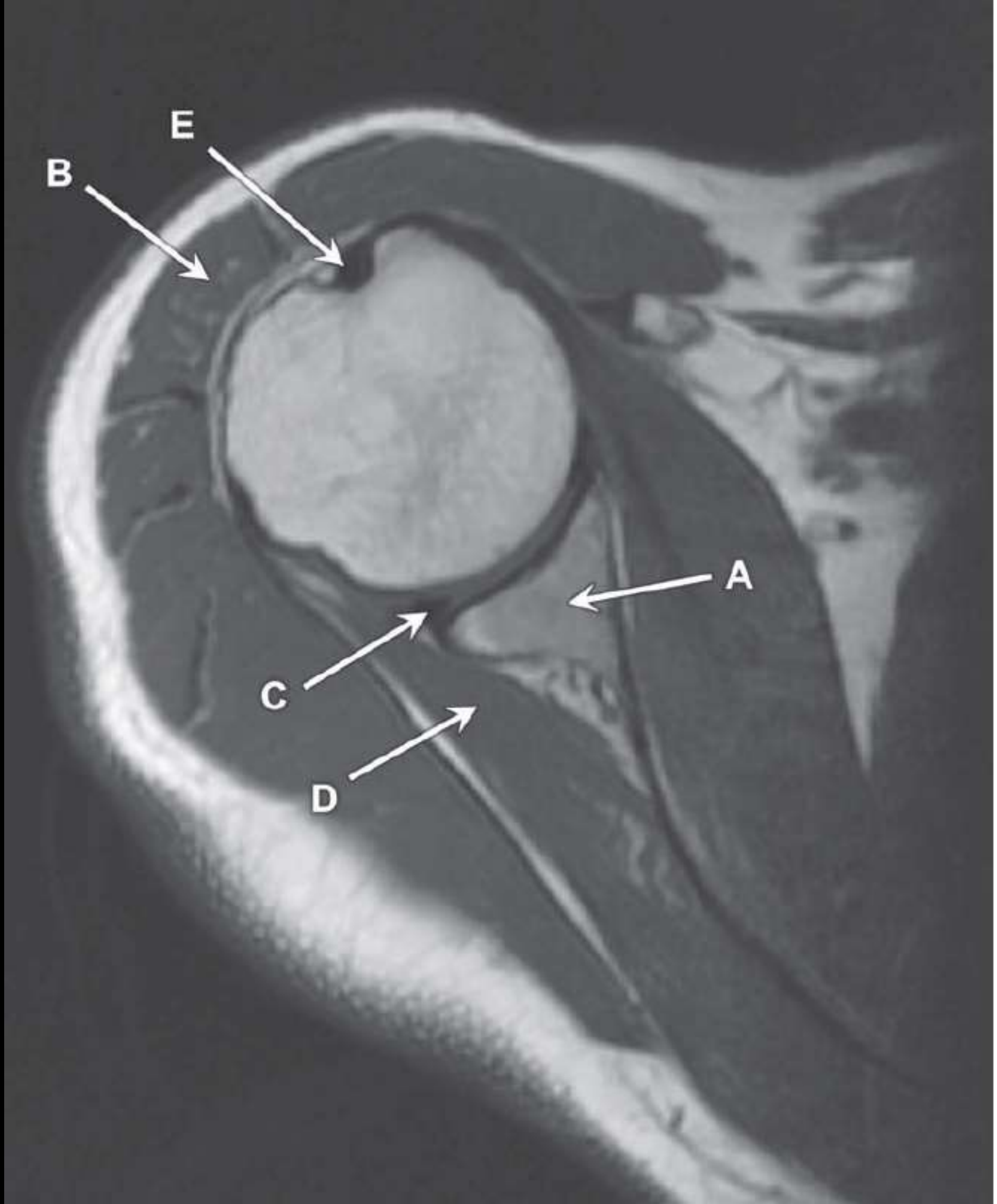
(e) Subscapularis. As its name suggests the subscapularis is a broad multi-pennate muscle that lies beneath the scapula. It becomes narrower laterally, as does the shape of the scapula, to form a broad tendon that inserts on the lesser tuberosity of the humerus which acts to internally rotate the shoulder.


36
37
38
39
40

MRI Shoulder

36. Right deltoid muscle
37. Right biceps brachii tendon (long head, in bicipital groove)
38. Right subscapularis (muscle/tendon)
39. Right infraspinatus muscle
40. Lung (apex right lung)

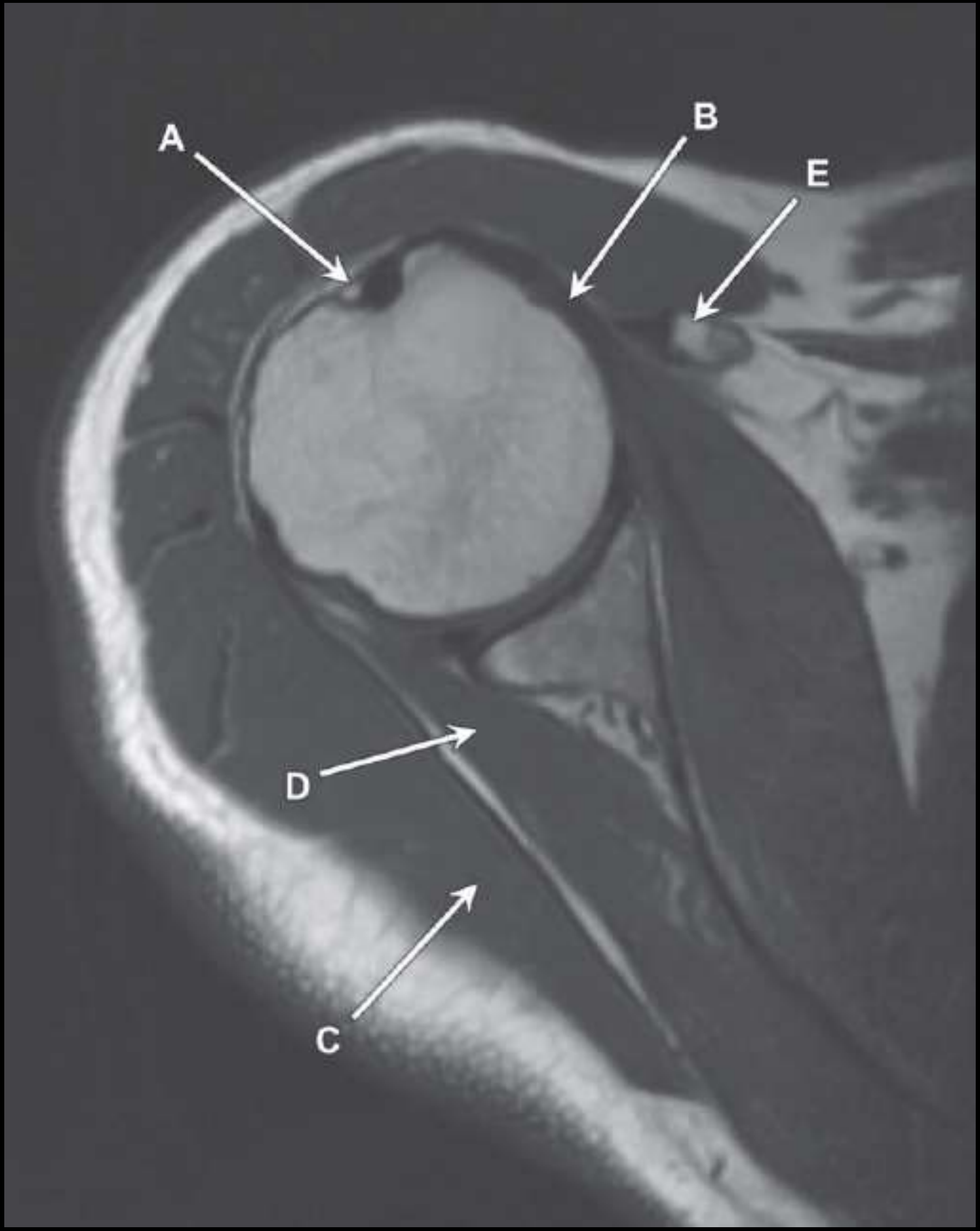
This is an axial T1-weighted MR shoulder.


E
B
A
C
D

Case 14

MRI shoulder. T1 weighted. Axial.

1. Glenoid
2. Deltoid muscle
3. Glenoid labrum
4. Infrapinatus muscle
5. Long head of biceps tendon

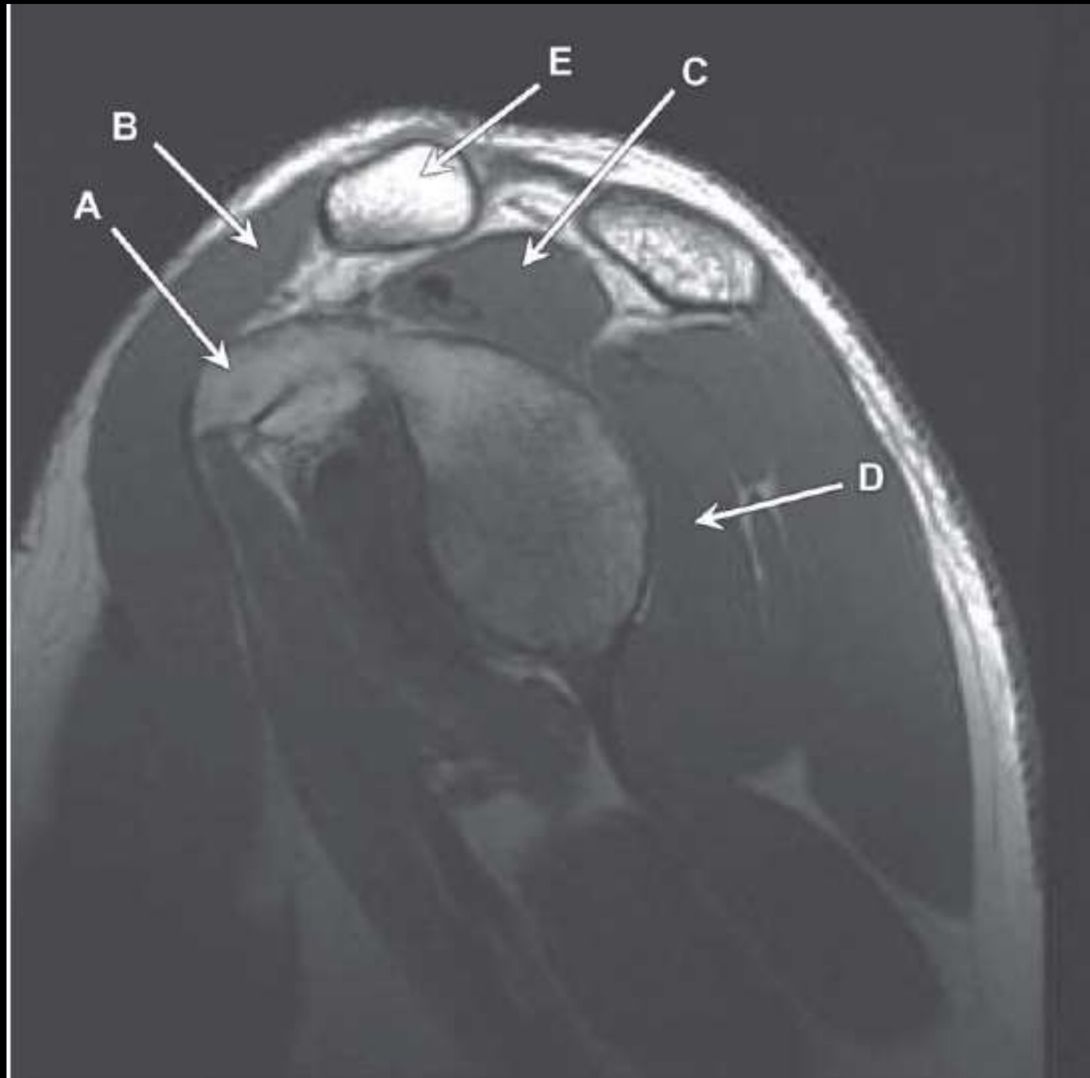

A
B
E
D
C

Case 9

MRI shoulder. T1W axial section.

1. Transverse humeral ligament
2. Tendon of the subscapularis muscle
3. Deltoid muscle
4. Infraspinatous muscle
5. Coracoid process of the scapula

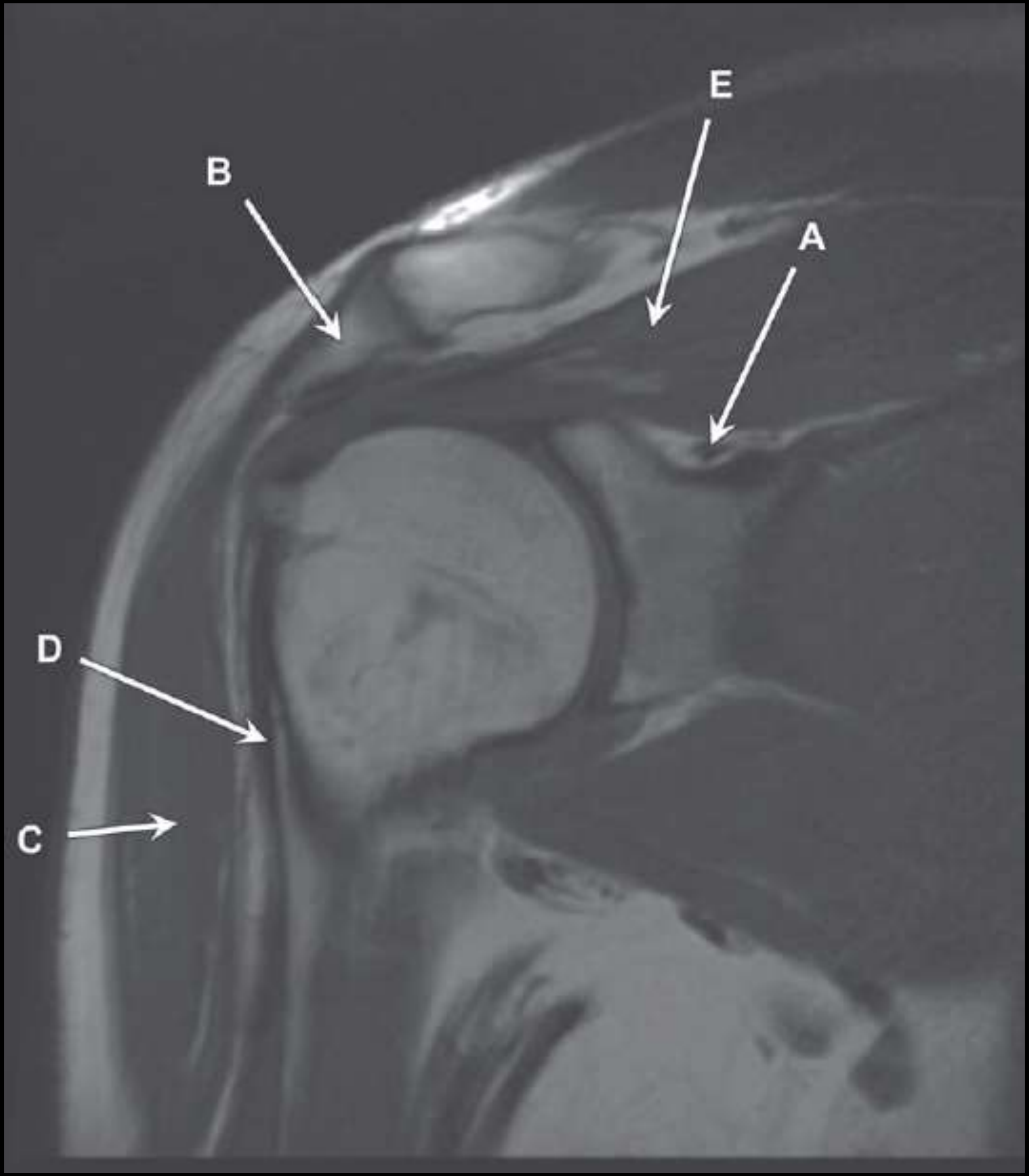
The transverse humeral ligament spans the biceps groove and is inseparable from the distal subscapularis muscle. At this level, the muscle posterior to the scapula must be infraspinatus (supraspinatous is much higher).


E
C
B
A
D

Case 20

MRI shoulder. Sagittal oblique T1W section.

1. Coracoid process
2. Deltoid muscle
3. Supraspinatus muscle
4. Infraspinatus muscle
5. Clavicle


E
B
A
D
C

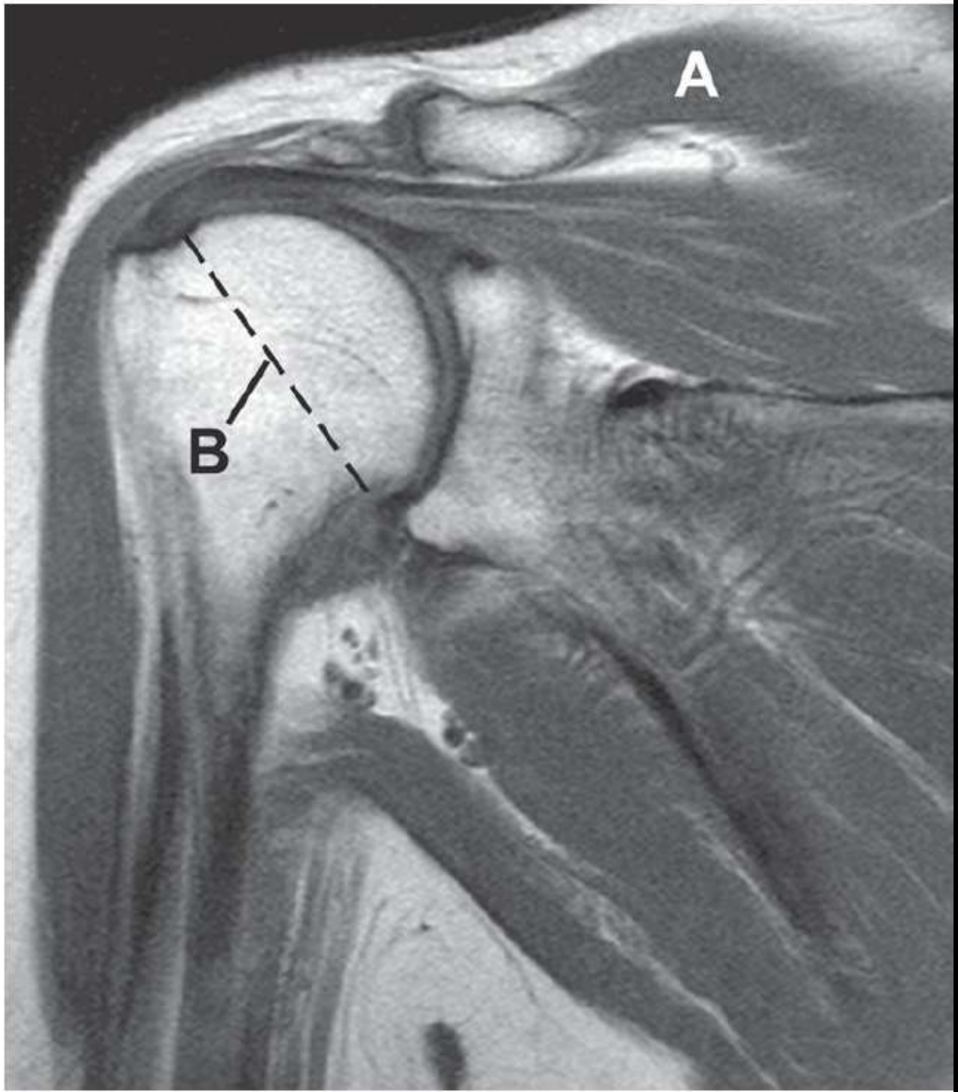
Case 12

MRI shoulder. T1W coronal section.

1. Suprascapular vein
2. Acromion
3. Deltoid muscle
4. Long head of biceps tendon
5. Supraspinatus muscle

Q12

a Name the structure labelled A
b Name the structure outlined and labelled B
c Name the four rotator cuff muscles
d Name the anatomical landmark that defines the upper border of the brachial vessels
e Name the five terminal branches of the brachial plexus



Q12 Answers

a Trapezius muscle
b Anatomical neck of humerus
c Supraspinatus, infraspinatus, teres minor and subscapularis
d Lower border of teres major
e Axillary, radial, ulnar, median and musculocutaneous nerves

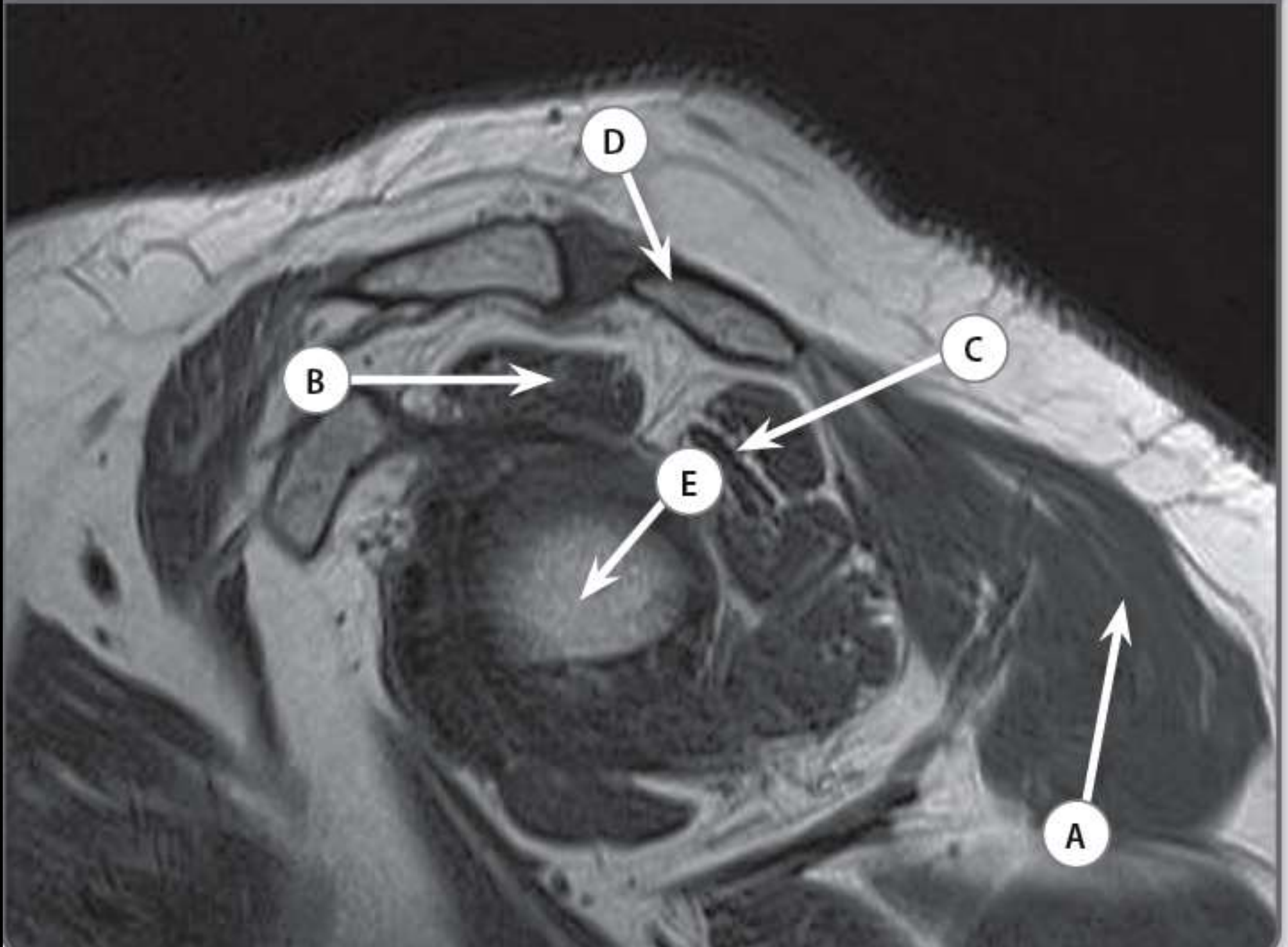
T1W MRI of shoulder, coronal section

The trapezius muscle (upper fibres) is used to shrug the shoulders by raising and rotating the scapula and raising the distal clavicle. It attaches distally to the lateral third of clavicle, acromion and spine of scapula.

The brachial vessels of the arm are continuous with the axillary vessels; they leave the axilla by passing distal to the lower border of teres major.

Most nerve supply to the upper limb derives from the brachial plexus. The nerve roots of C5 to T1 combine and cross before the five terminal nerves are formed. These nerves enter the arm surrounding the brachial artery.

Case 5.14



Case 5.14

A Deltoid

B Supraspinatus

C Infraspinatus

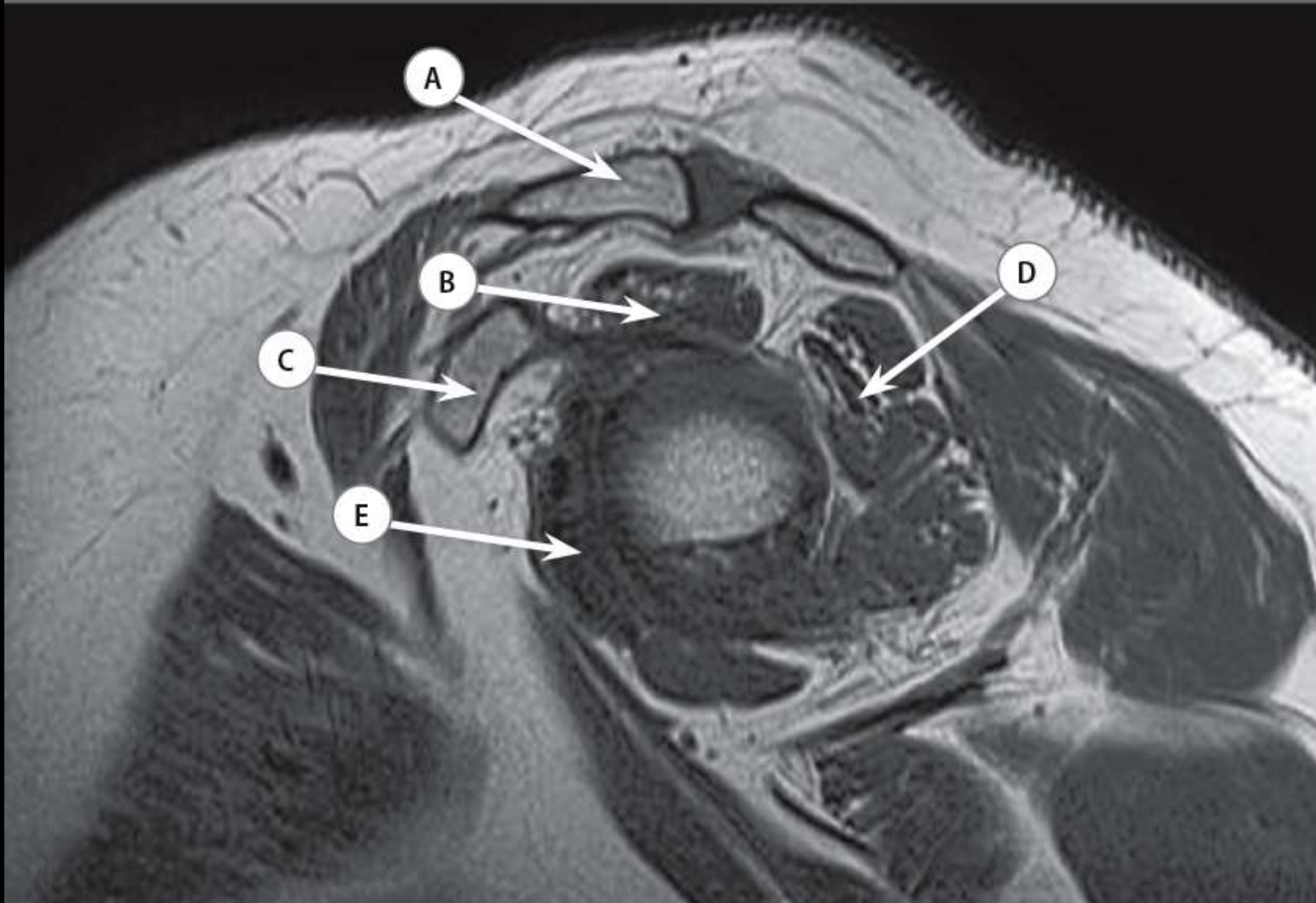
D Acromion

E Head of humerus

Sagittal oblique MRI of the shoulder.

For further discussion see Chapter 4, Case 4.43.

Case 4.41



Case 4.41

A Clavicle

B Belly of supraspinatus

C Coracoid process

D Belly of infraspinatus

E Subscapularis

Sagittal oblique MRI of the shoulder.

The rotator cuff is a group of four short muscles between the scapula and the upper humerus that is essential to the stability of the shoulder joint. The tendons are intimately related to the capsule of the joint.

From anterior to posterior:

The subscapularis attaches to the convex, costal surface of the scapula and inserts into the lesser tubercle.

The supraspinatus arises from the supraspinous fossa (posterior aspect of the scapula) and inserts onto the greater tubercle.

The infraspinatus arises from the infraspinous fossa and the greater tubercle.

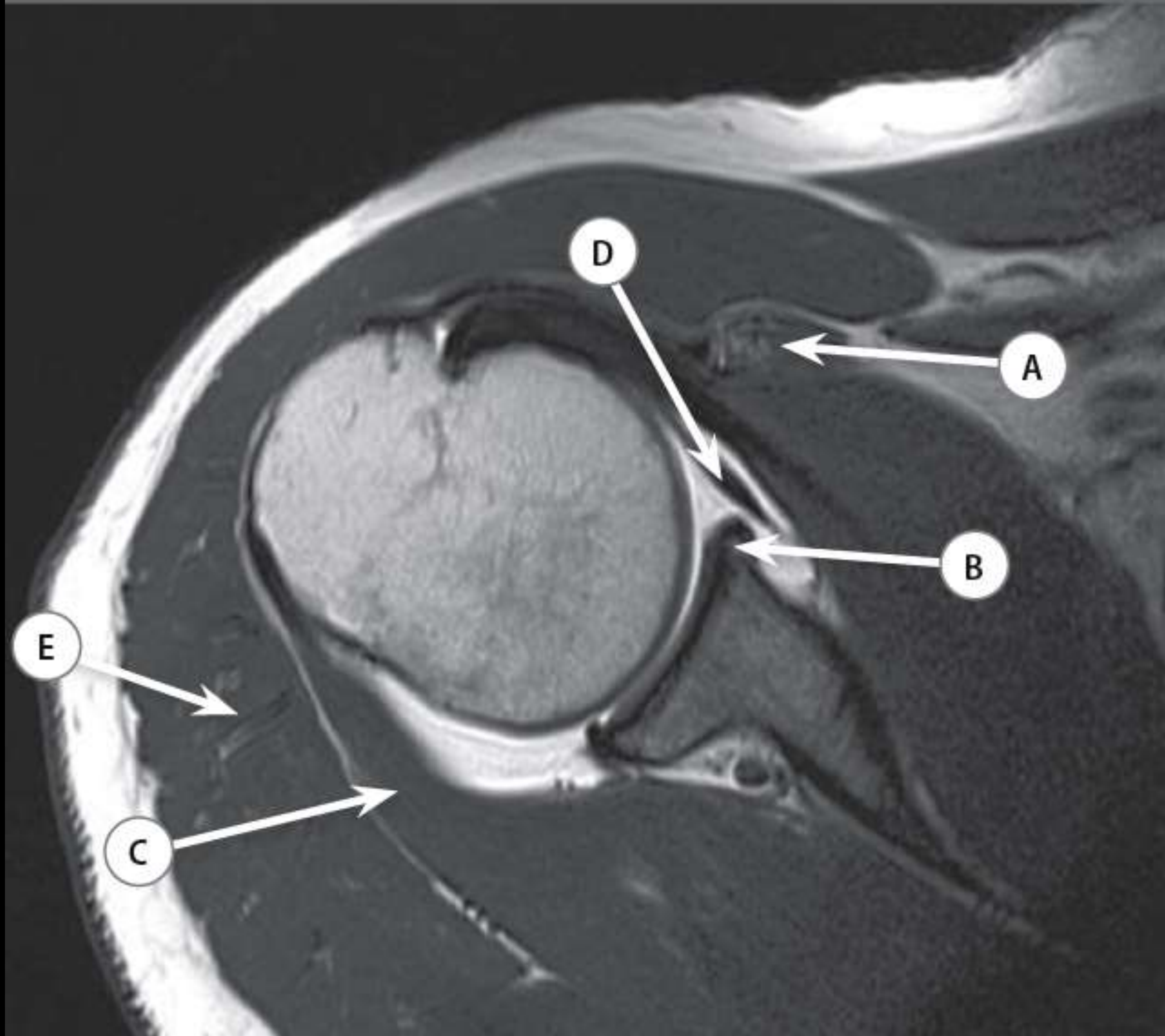
The teres minor arises from the lateral margin of the scapula and inserts onto the greater tubercle.

This image may look daunting at first, but identifying different structures is easy once you are able to differentiate anterior from posterior. The key to this is the coracoid process which lies anterior to the glenohumeral joint. The clavicle lies superiorly and the acromion lies posteriorly.

The deltoid can also be seen on this image. It is the large abductor muscle of the shoulder.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 80.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 261–263.

Case 4.42



Case 4.42

A Coracoid process

B Anterior glenoid labrum

C Infraspinatus

D Middle glenohumeral ligament

E Deltoid

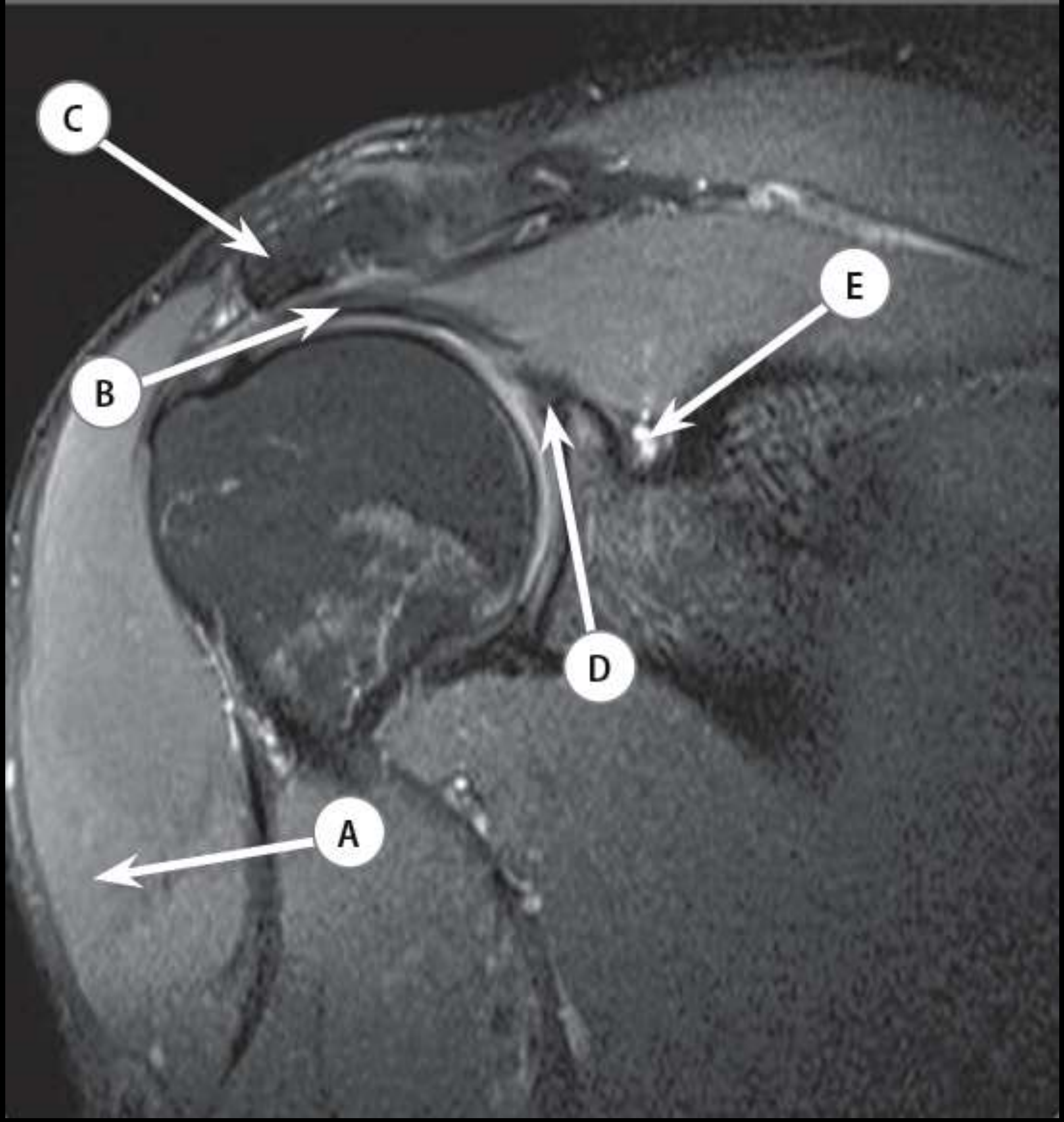
Axial MRI of the shoulder at the level of the glenohumeral joint.

The coracoid process is a useful landmark to help identify the orientation of this image. It lies anteriorly. The glenoid process of the scapula articulates with the head of humerus and is easily identifiable by its shape. The articular surface of the glenoid is deepened by the labrum: a rim of fibrous tissue.

The muscles of the rotator cuff are discussed in the previous question. Note that in an axial image, at the level where the glenoid is at its widest, the rotator cuff muscle anteriorly is the subscapularis and posteriorly is the infraspinatus.

The capsule is attached to the epiphyseal line of the glenoid and the humerus except inferiorly, where it forms the axillary pouch by expanding on the medial aspect of the neck of humerus. There are three anterior thickenings of the capsule, the three glenohumeral ligaments. They pass from the upper part of the glenoid to the lesser tuberosity and the inferior part of the head of humerus

Case 4.43



Case 4.43

A Deltoid

B Supraspinatus tendon

C Acromion

D Superior labrum

E Suprascapular notch (containing suprascapular nerve, artery and vein)

Coronal oblique image of the shoulder.

It is important to note that it is the tendon rather than the muscle belly of supraspinatus that passes under the acromion. Therefore, make sure this is indicated in the answer. Simply writing 'supraspinatus' may not be enough to get both marks.

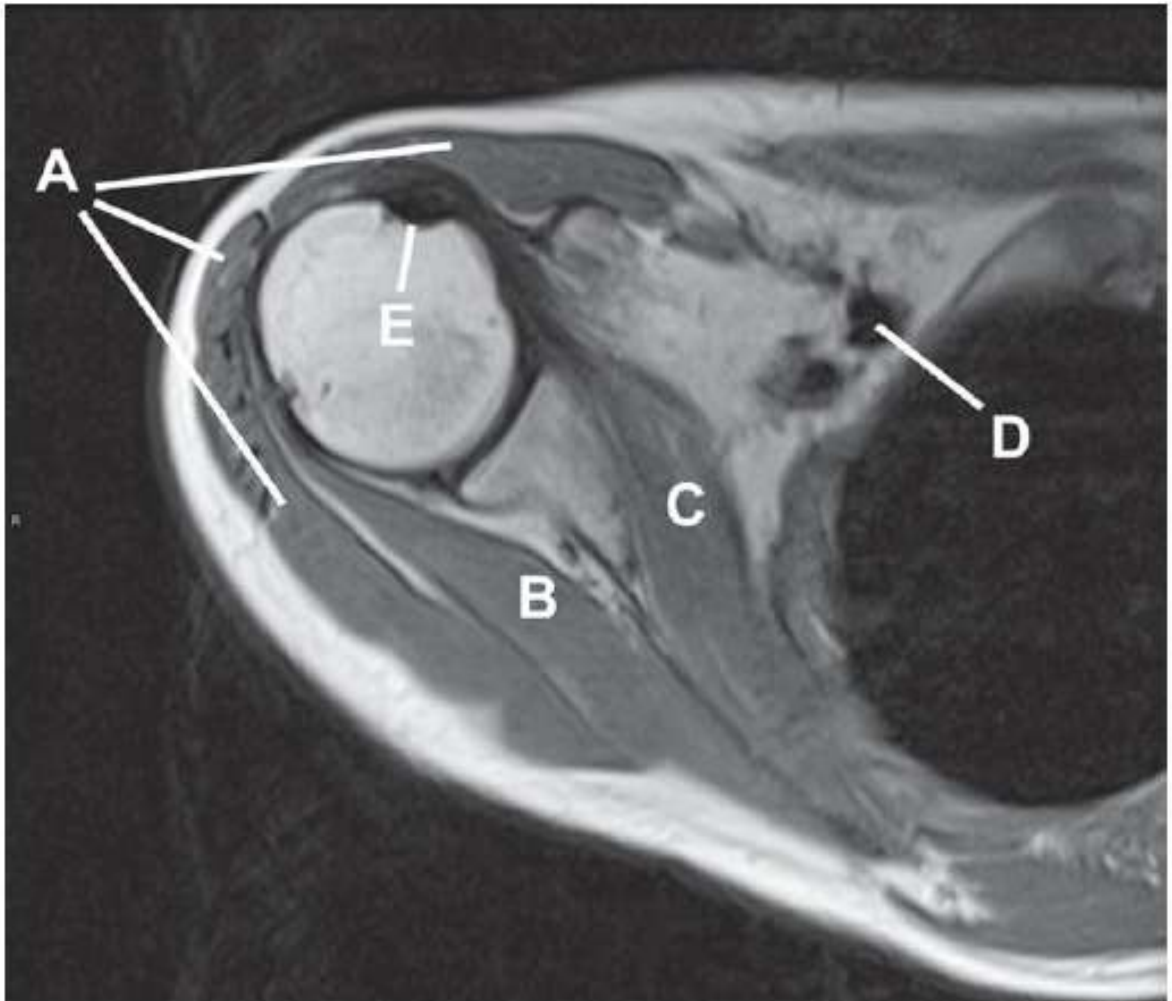
The suprascapular notch is an easily identifiable landmark. The suprascapular neuromuscular bundle passes through it to reach the muscles that cover the posterior surface of the scapula: the supraspinatus and infraspinatus.

The shoulder joint has now been viewed in sagittal oblique, axial and coronal oblique. This series illustrates that a three dimensional understanding of the anatomy is necessary for this exam. When reading about a structure, try to find images from different radiographic projections and different MR orientations to help form a three dimensional image.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 81.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 261.

Q3

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the structure that runs through the groove labelled E



Q3 Answers

a Deltoid muscle
b Infraspinatus muscle
c Subscapularis muscle
d Axillary vein
e The long head of biceps tendon runs through the inter-tubercular groove

T1W MRI of shoulder at level of gleno-humeral joint, axial view

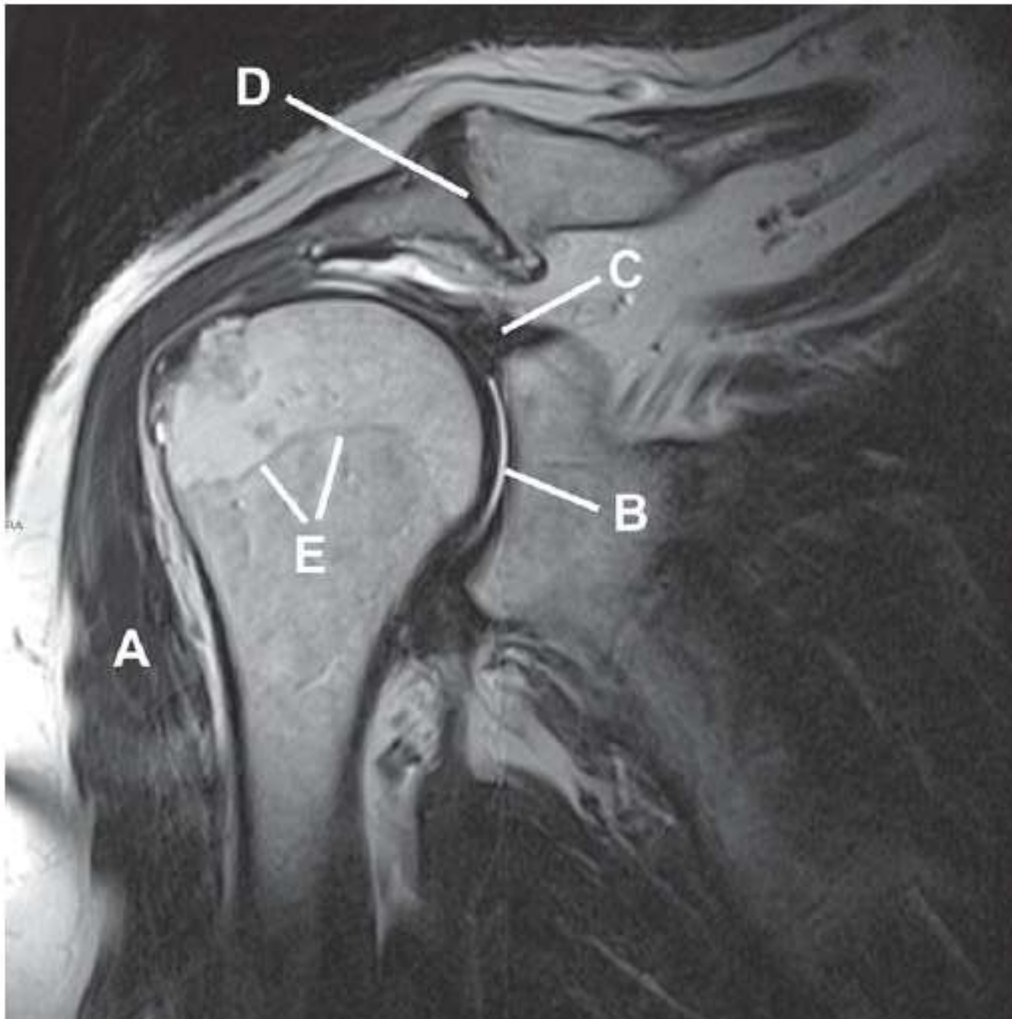
The rotator cuff muscles of the shoulder comprise supraspinatus, infraspinatus, subscapularis and teres minor. The tendons of these muscles coalesce with the articular capsule of the shoulder joint and provide stability by holding the humeral head in place. Distally the rotator cuff muscles attach to the greater and lesser tubercles of the humerus, although only the subscapularis attaches to the lesser tubercle. All but the supraspinatus are rotators of the humerus (supraspinatus is active at the initiation of arm abduction).

The deltoid muscle forms the contour of the shoulder. Running from the outer aspect of the lateral third of clavicle, over the acromion and along the outer aspect of the spine of the scapula, it lies more superficially than the rotator musculature. The deltoid is the major abductor of the arm.

Proximally, biceps brachii has two attachments. The long head tendon runs through the intertubercular groove of the humerus to reach the supraglenoid tubercle of the scapula. The short head of biceps attaches to the coracoid process of the scapula.

Q4

a Name the structure labelled A
b Name the high signalled structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the structure labelled E



Q4 Answers

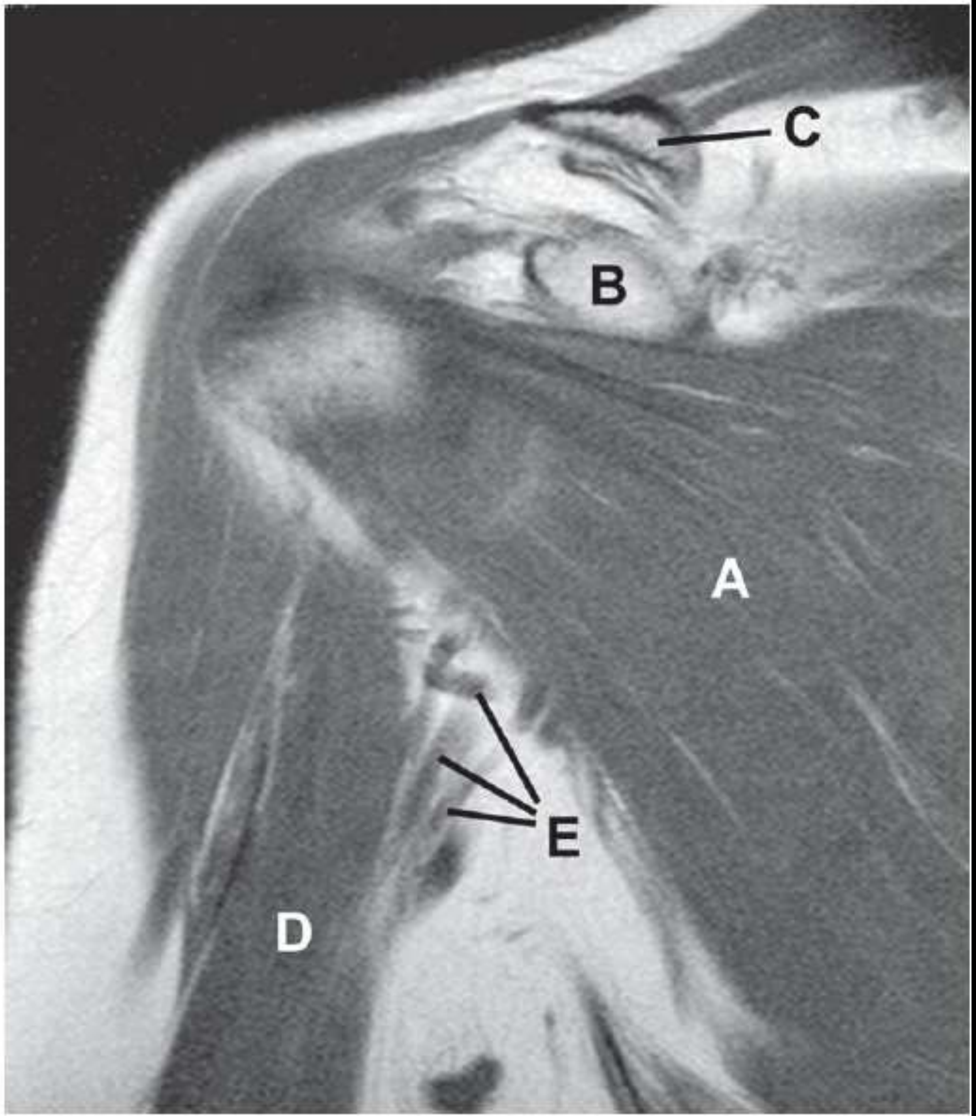
a Deltoid muscle
b Trace of synovial fluid within gleno-humeral joint
c Superior glenoid labrum
d Acromio-clavicular joint
e Epiphyseal line (fused)

T2W MRI of shoulder, coronal view

The gleno-humeral articulation of the shoulder is a synovial ball and socket joint. It is normal to see a trace of synovial fluid with T2W MRI; in cases of joint disease or trauma this fluid volume may be significantly increased. The glenoid is naturally shallow providing only limited support for the humeral head. This support is enhanced by a circumferential fibro-cartilaginous ring known as the glenoid labrum. MRI provides a means of identifying and assessing the glenoid labrum which appears as a low signal triangular structure arising from the periphery of the osseous glenoid. Administration of contrast into the synovial joint space enhances visualisation of this area and will more reliably demonstrate a tear of the labrum.

Q5

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the group of structures labelled E



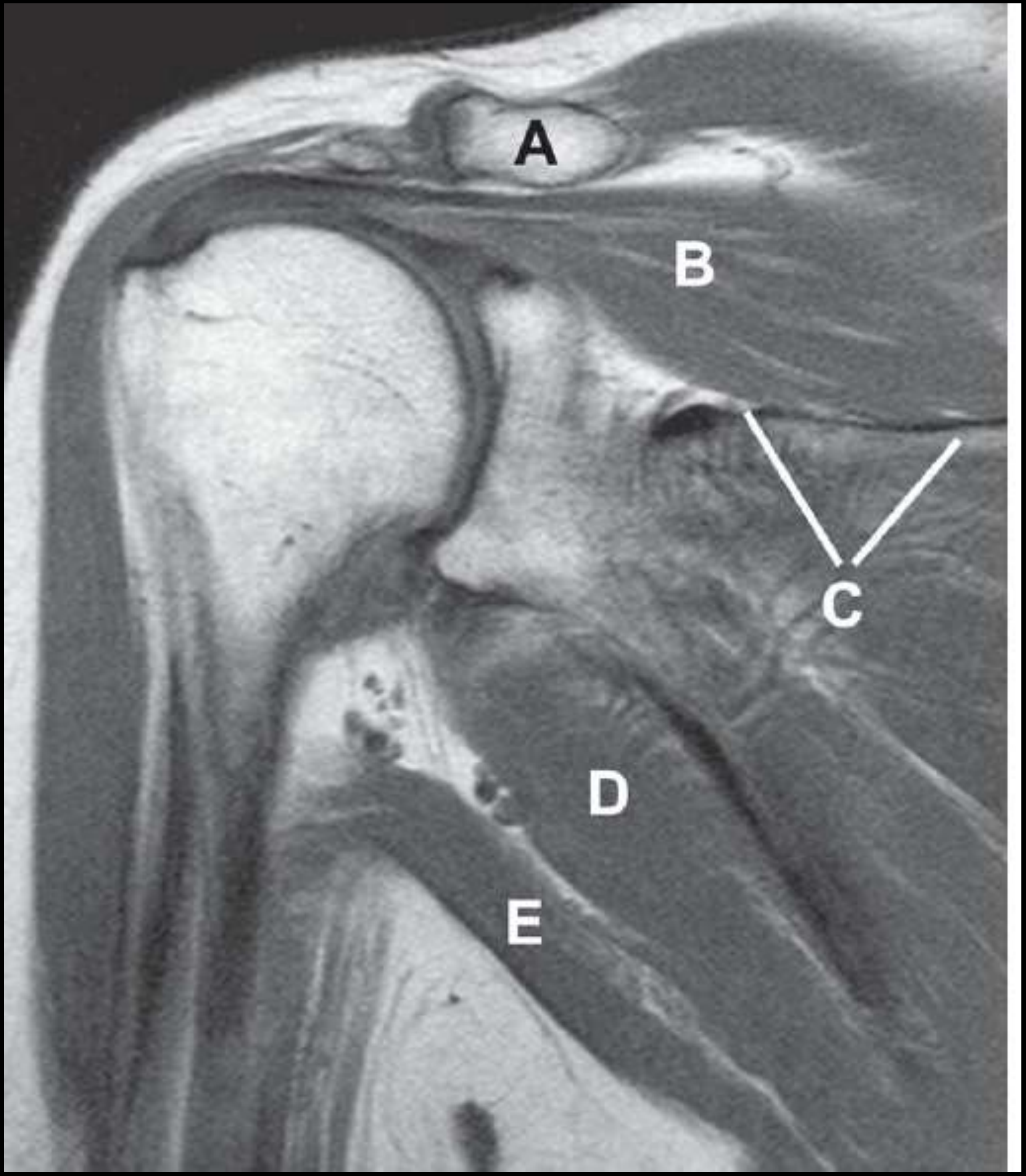
Q5 Answers

a Subscapularis muscle
b Coracoid process of the scapula
c Distal end of clavicle
d Biceps brachii muscle
e Axillary neurovascular bundle

T1W MRI of shoulder, coronal section

It can be difficult with a single cross sectional image to orientate oneself with the anatomy. Coronal sections of the shoulder are usually aligned with the scapula which lies at an oblique angle (approximately 30 degrees antero-medially to postero-laterally) to the shoulder in the true coronal plane. The pectoralis major can be confused with the subscapularis in this scenario. Note however the region of muscle attachment; the subscapularis attaches to the lesser tubercle of the humerus which is part of the humeral head. Conversely, the pectoralis major attaches along the lateral edge of the intertubercular groove more distally on the humerus near the surgical neck. The MRI section provided here is anterior to the humerus but posterior to the thorax on the anterior border of the scapula. It is worth looking at an axial view of the shoulder on MRI to appreciate the orientation of this view. Note also the trapezius and deltoid muscles in this image.

The axillary neurovascular bundle runs anterior to the subscapularis muscle as it enters the arm.


A
B
C
D
E

Q6 Answers

a Acromion process of the scapula
b Supraspinatus muscle
c Spine of scapula
d Teres minor muscle
e Teres major muscle

T1W MRI of shoulder, coronal section

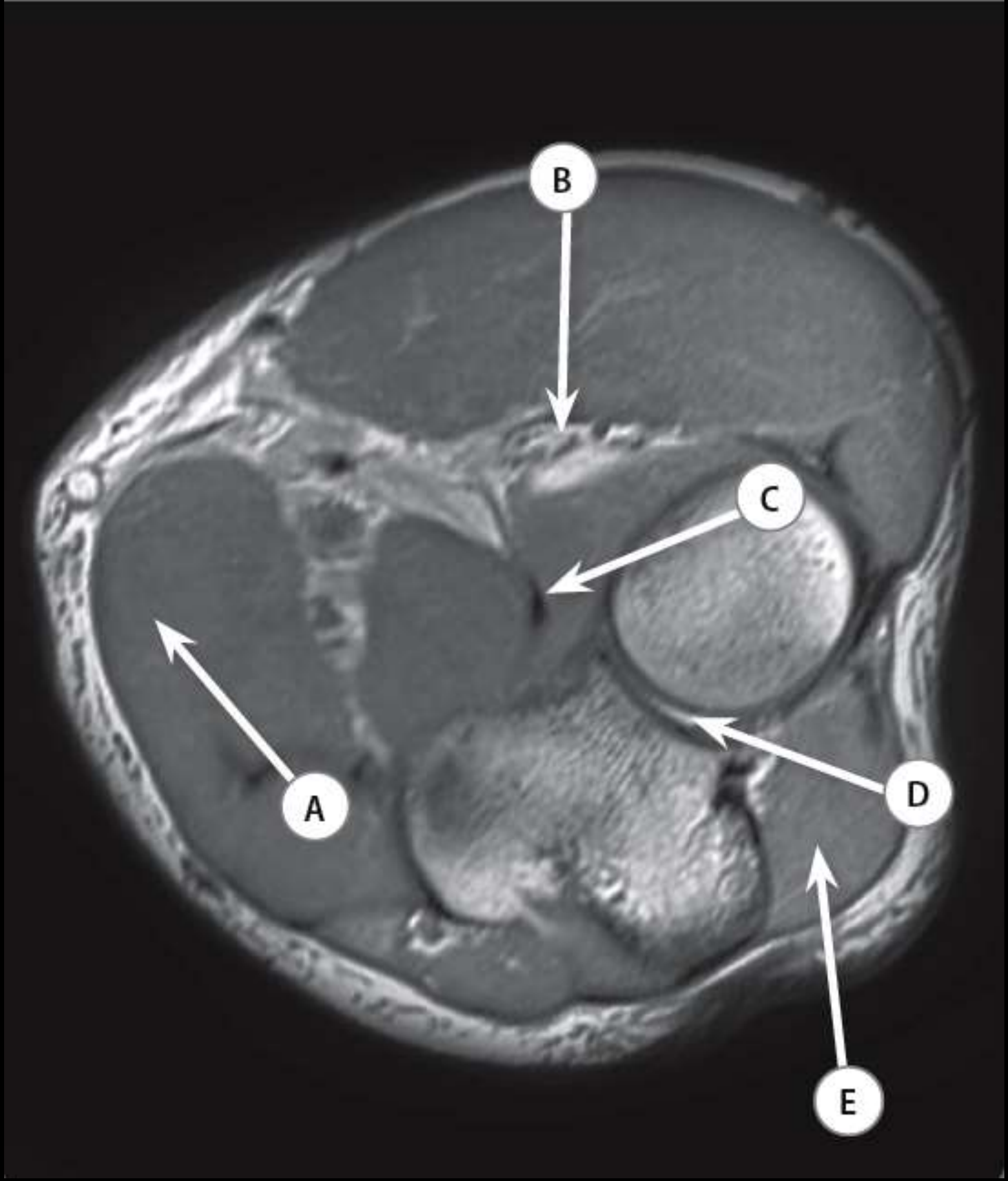
The four rotator cuff muscles of the shoulder are the supraspinatus, infraspinatus, teres minor and subscapularis. The supraspinatus tendon runs through the subacromial space (as shown) where it is prone to 'wear and tear', especially if there is bony stenosis of the space.

The teres major muscle lies nearly parallel with the teres minor and also originates from the lower border of the scapula. The teres major is different in its distal attachment; it is not part of the rotator cuff, instead it attaches to the medial lip of the intertubercular groove more distally on the humerus.

The axillary nerve (a posterior branch of the brachial plexus supplying deltoid and skin over deltoid) and circumflex humeral vessels pass through the space between teres major and minor (as shown). This is known as the quadrangular space; its medial and lateral borders are the long head of triceps and the humerus, respectively.

ELBOW

Case 4.35



Case 4.35

A Flexor carpi ulnaris

B Radial nerve

C Biceps tendon

D Proximal radioulnar joint

E Anconeus

Axial MRI of the elbow joint at the level of the proximal radioulnar joint.

There are two joints between the radius and the ulna: the superior and inferior radioulnar joints. The shafts are also united by an interosseous membrane.

The flexor carpi ulnaris is one of the superficial flexors in the forearm. It flexes the wrist joint and abducts the hand. The superficial group in the flexor compartment of the forearm is made of five muscles that fan out like the digits of a hand. From medial to lateral, these muscles are:

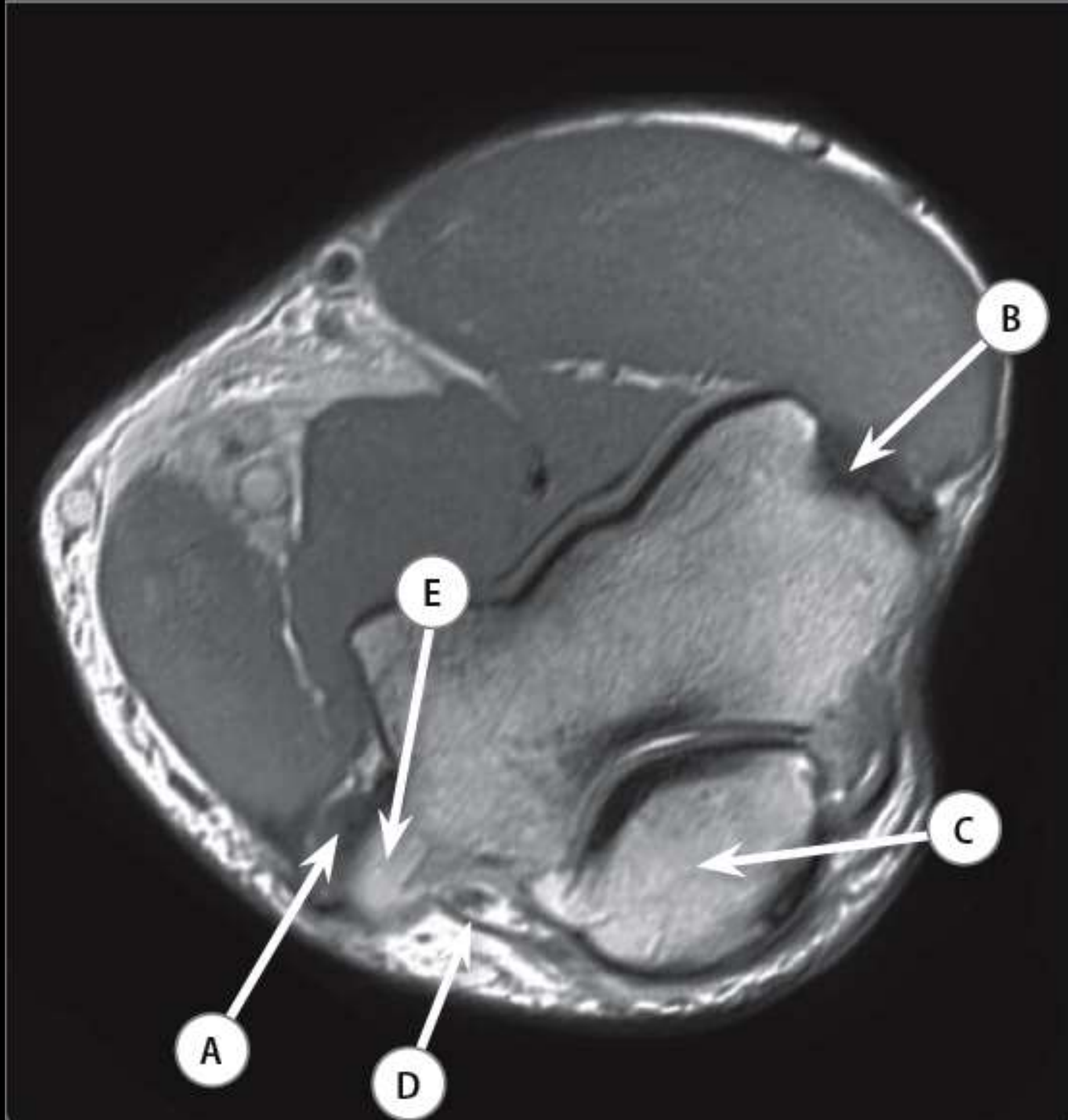
- pronator teres
- flexor carpi radialis
- palmaris longus
- flexor digitorum superficialis
- flexor carpi ulnaris

The anconeus is a small muscle on the posterior aspect of the elbow joint. Its proximal attachment is the lateral epicondyle of the humerus. It inserts distally on the posterior aspect of the olecranon. It acts as an extensor of the forearm.

Note the position of the biceps tendon and the radial nerve at this level. In the arm, the radial nerve travels deep to the lateral head of the triceps. It pierces the intermuscular septum and comes to lie between the brachialis and brachioradialis it passes into the forearm from the anterior aspect of the elbow.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 84.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 266.

Case 4.36



Case 4.36

A Common flexor tendon insertion

B Common extensor tendon insertion

C Olecranon

D Ulnar nerve

E Medial epicondyle

Axial MRI of the elbow at the level of the humeral condyles.

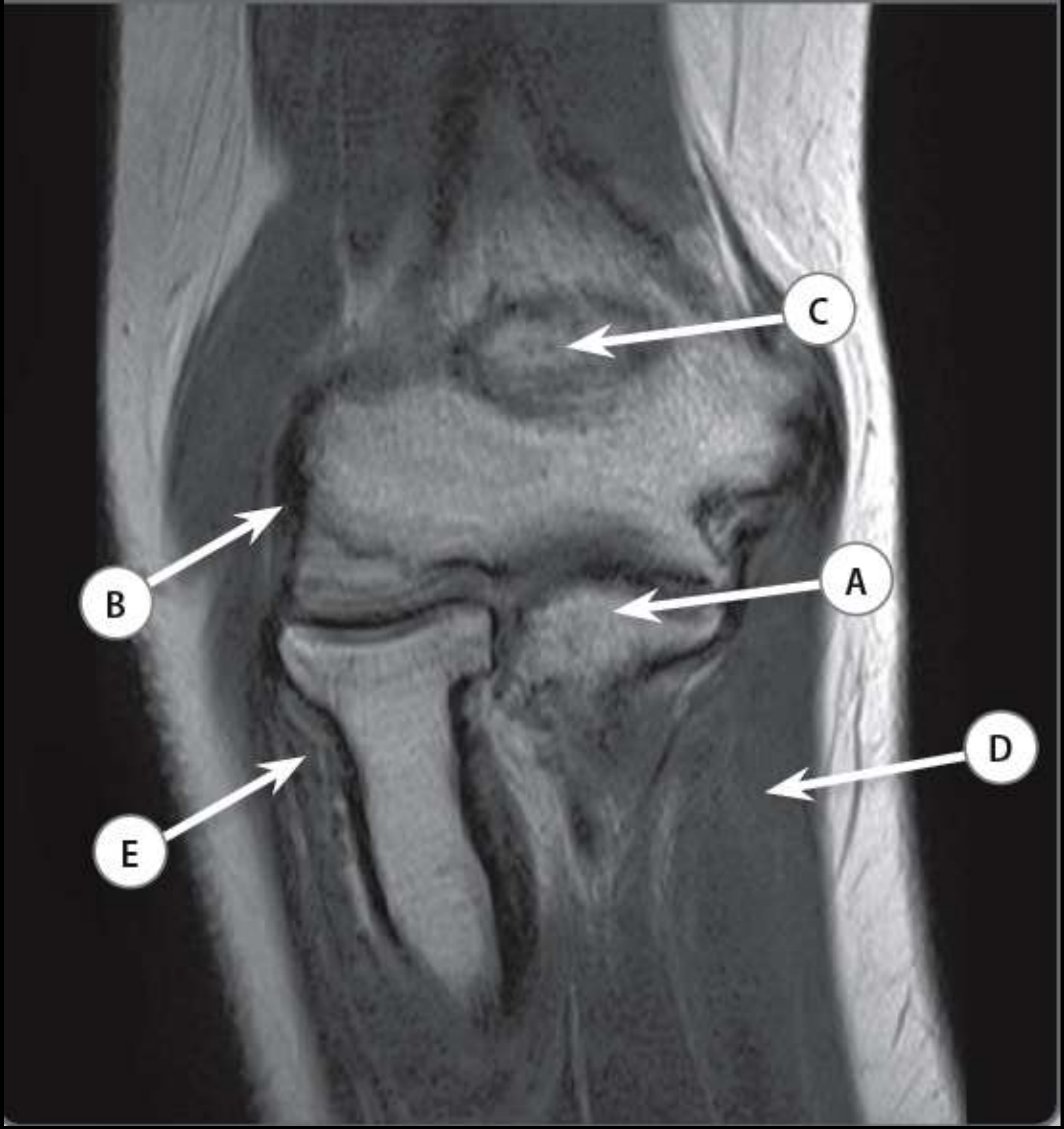
The muscles of the forearm are broadly divided into two groups according to whether they lie on the front or the back of the forearm. The muscles are the front of the forearm act to pronate the forearm and flex the wrist. Those at the back supinate the forearm and extend the wrist.

Both the flexor and extensor compartments are arranged in superficial and deep layers. Each superficial stratum arises from an epicondyle of the humerus. The flexors arise from the medial epicondyle (common flexor tendon insertion or common flexor origin) and the supracondylar ridge. The extensors arise from the lateral (common extensor tendon insertion or common extensor origin) and the supracondylar ridge. Each deep stratum arises from the forearm bones and interosseous membrane.

The ulnar nerve passes down the arm medial to the brachial artery. It pierces the medial intermuscular septum halfway down. It continues distally covered by the medial head of triceps. As seen in this image, it passes on the posterior aspect of the medial epicondyle to enter the forearm between the heads of flexor carpi ulnaris.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 84.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 266.

Case 4.37



Case 4.37

A Coronoid process of the ulna

B Radial collateral ligament

C Olecranon fossa

D Flexor carpi radialis

E Supinator

Coronal MRI of the elbow joint.

The elbow joint incorporates three articulations: the humeroulnar, the humeroradial and the proximal radioulnar.

The articular surfaces are:

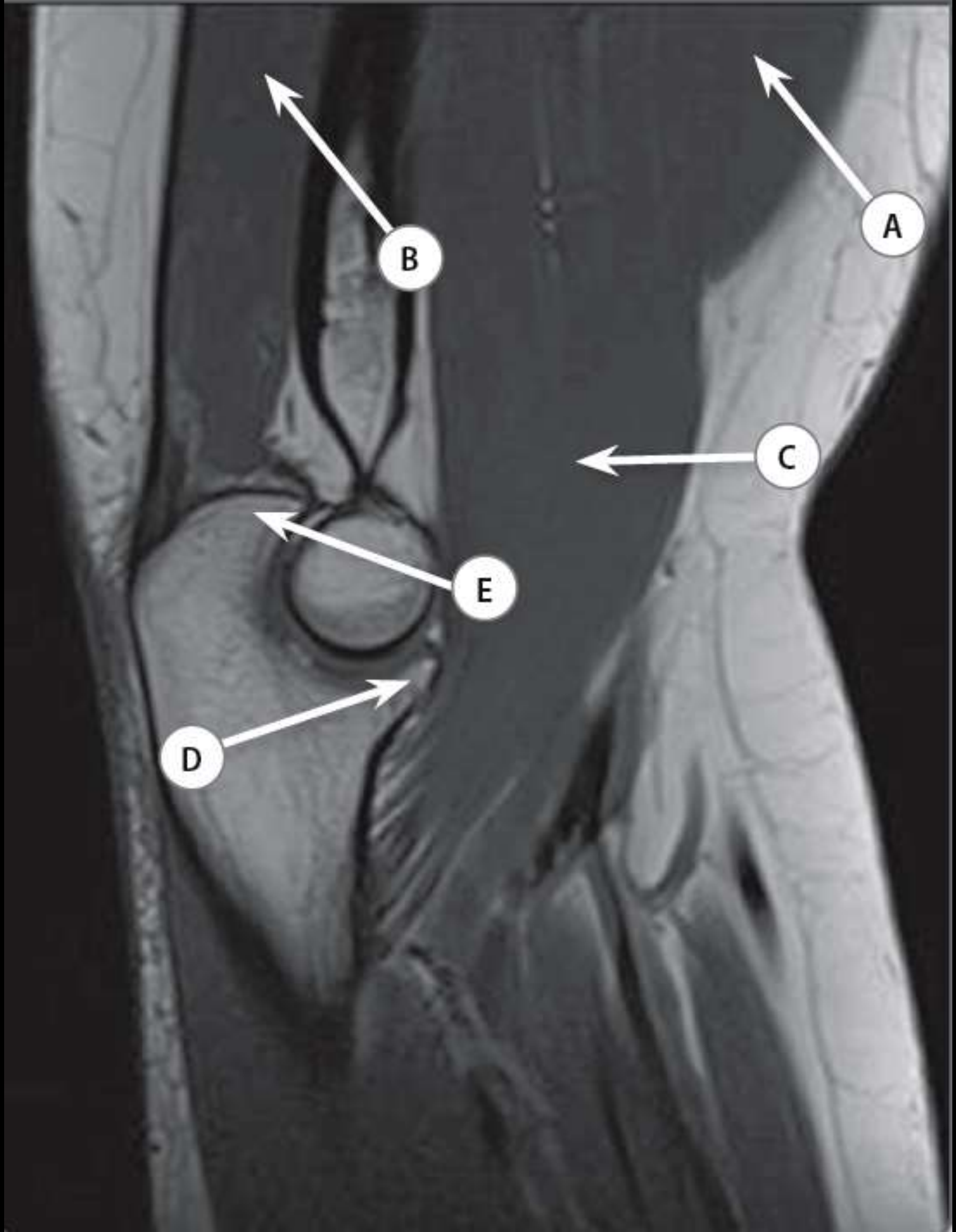
- **humerus**: capitellum laterally and trochlea medially
- **radius**: the upper surface of the head of radius and the ulnar notch
- **ulna**: the trochlear fossa and radial notch.

The radial and ulnar collateral ligaments are thickenings of the capsule that provide support. Another important ligament of the elbow to be aware of is the annular ligament. It is attached on the anterior and posterior edges of the radial notch of the ulna and surrounds the head of radius which rotates within it.

The radial collateral ligament is attached proximally to the lateral epicondyle of the humerus and distally to the annular ligament. The ulnar collateral ligament is attached proximally to the medial epicondyle and distally, to the medial side of the olecranon and the coronoid process of the ulna.

Two muscles are labelled on this image; on the lateral and medial side. Medially is the flexor carpi radialis, a superficial flexor in the forearm which flexes the wrist joint and adducts the hand. On the lateral side is the supinator which inserts into the neck and shaft of radius.

Case 4.38



Case 4.38

A Biceps

B Triceps tendon

C Brachialis

D Coronoid process

E Olecranon process

Sagittal MRI of the elbow (ulnar side).

Biceps is composed of a long head and a short head. Distally the two muscle bellies share a single tendon insertion on the bicipital tuberosity of the radius. The muscle flexes the elbow joint and supinates the forearm. It also helps to flex the shoulder joint.

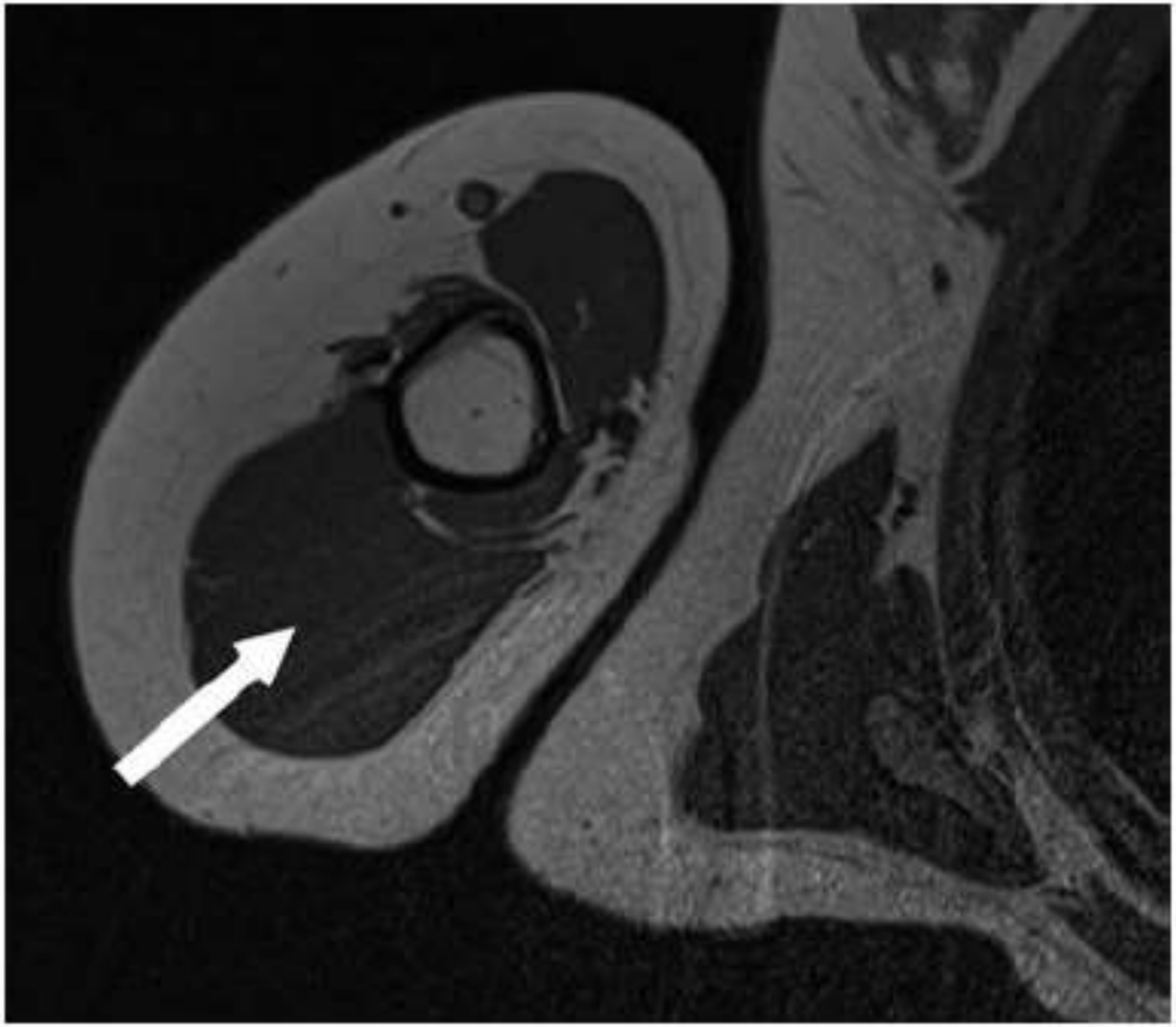
Brachialis lies deep to the biceps on the anterior aspect of the humerus. It arises from the lower half of the humerus and inserts by a short tendon into the coronoid process of the ulna.

Triceps is a large muscle on the posterior aspect of the arm. It has three heads: the long, lateral and medial. In the mid arm, the three heads unite to form a common tendon which inserts on the posterosuperior aspect of the olecranon.

Be sure to indicate whether a structure is a tendon or a muscle as failure to do so may lead to unnecessary loss of marks. Tendons are dark linear structures on MRI. Remember that a tendon connects a muscle to a bone while a ligament connects two bones.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 82.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 265.

Question 11:

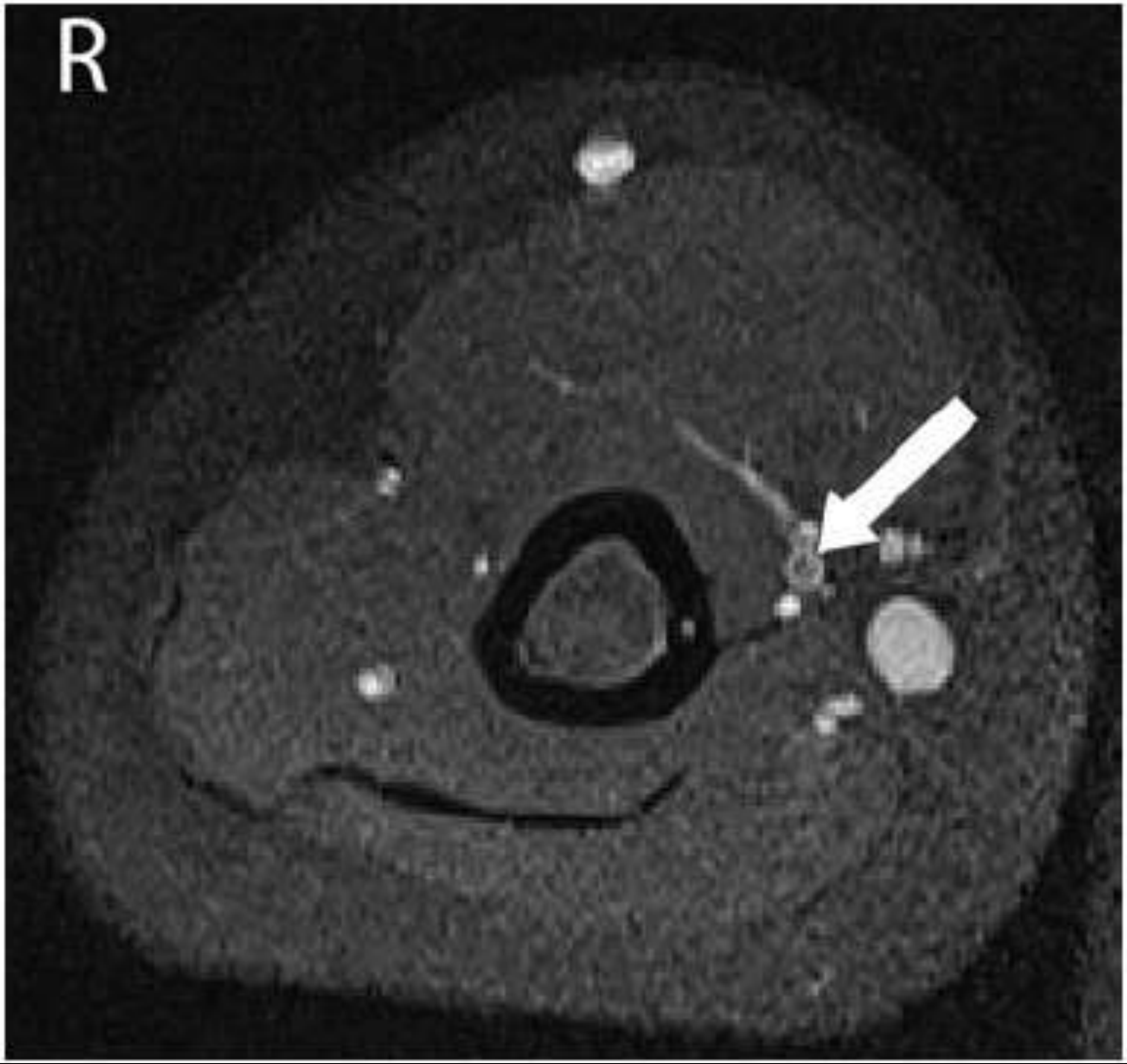


Question 11: Axial MRI of the upper limb

Answer: Triceps brachii muscle

- As its name infers, the triceps brachii ('three headed muscle of the arm') muscle is formed from three proximal muscle bundles (long/lateral/medial heads) that arise from the posterior aspect of the upper limb to join together at the elbow before inserting onto the olecranon process of the ulna.

Question 37:

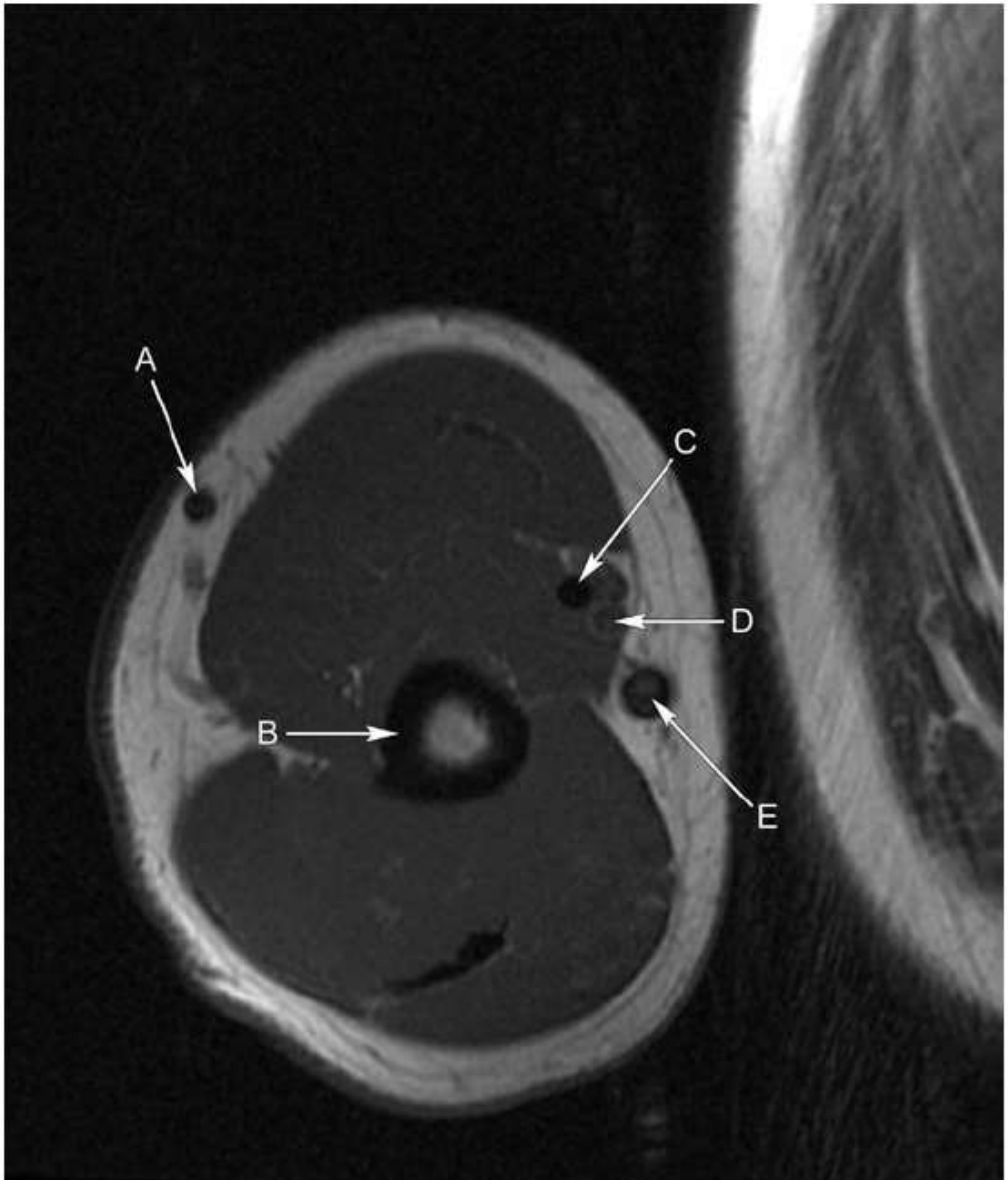


Question 37: Axial MRI of the right arm

Answer: Right brachial artery

- Although detailed knowledge of neurovascular anatomy is not required for the examination, do not neglect it as part of your revision because it is a common topic.
- The brachial artery is the distal continuation of the axillary artery beyond the lower margin of teres minor muscle. It bifurcates into the radial and ulnar arteries, which run through the forearm.
- At the elbow joint, the biceps brachii tendon lies lateral to the brachial artery.

Question 4.17

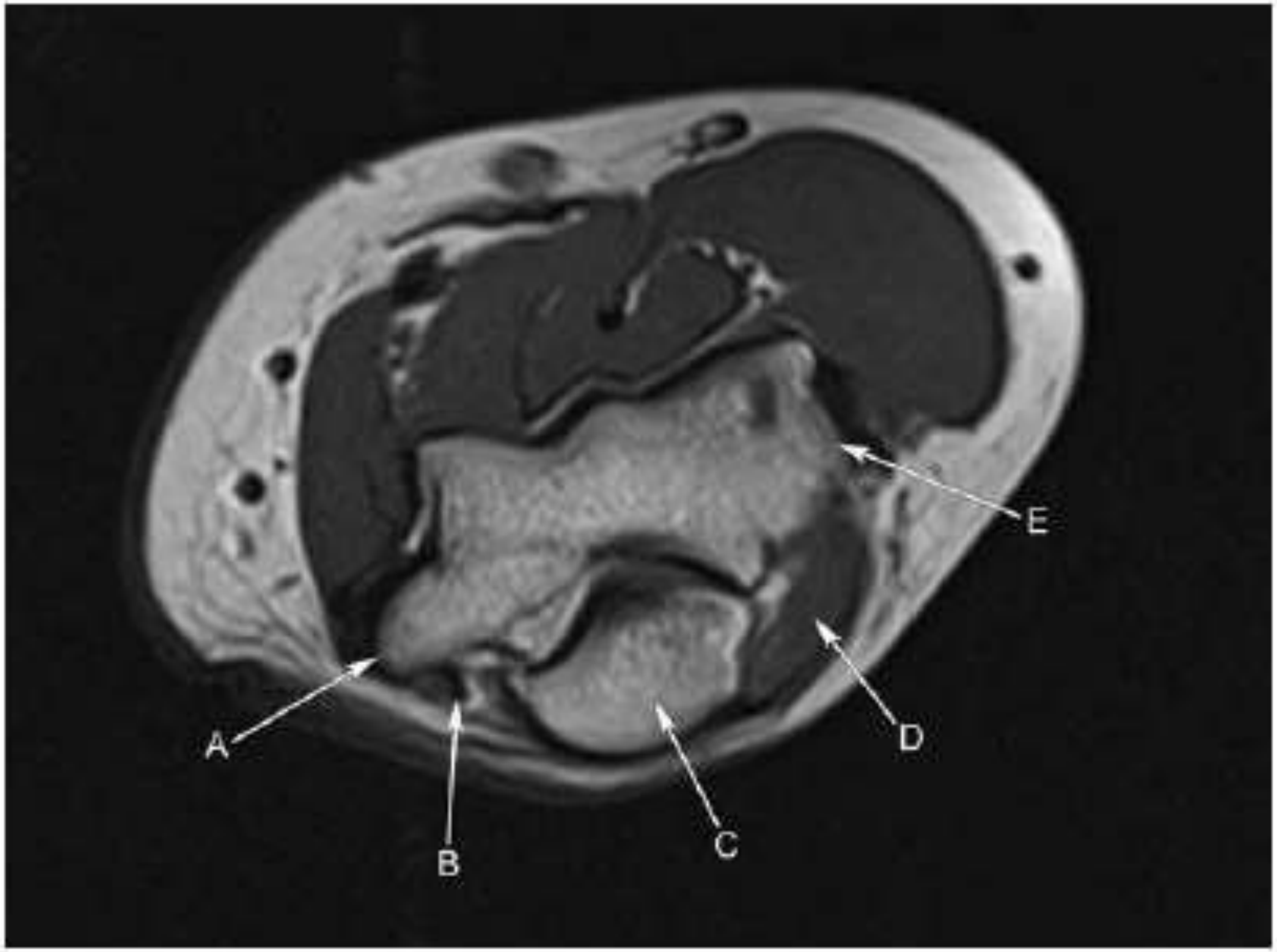


4.17 Axial T1 MRI of the right arm

A Right cephalic vein.
B Right humerus.
C Right brachial vein.
D Right brachial artery.
E Right basilic vein.

The cephalic and basilic veins are superficial veins of the arm. The cephalic vein commences on the radial side of the dorsal venous network on the hand and ascends along the radial border of the arm. The cephalic vein then courses along the lateral border of the biceps before piercing the coracoclavicular fascia to drain into the axillary vein. The basilic vein commences on the ulnar side of the dorsal venous network and ascends up the medial border of the biceps brachii of the upper arm before continuing as the axillary vein at the lower border of the teres major. The brachial vein is a deep vein of the arm and travels alongside the brachial artery before joining the axillary vein at the lower border of the subscapularis.

Question 10.11



This is an axial MRI of the left elbow.

A Which shared tendon inserts here?

Name the structures labelled **B** to **D**.

E Which shared tendon inserts here?

10.11 Axial T1 MRI of the left elbow

A Common flexor tendon (medial epicondyle of the humerus).
B Ulnar nerve.
C Olecranon.
D Anconeus.
E Common extensor tendon (lateral epicondyle of the humerus).

The common flexor tendon is a common tendinous origin at the medial epicondyle o the humerus and is shared by a number of flexor muscles of the anterior compartme

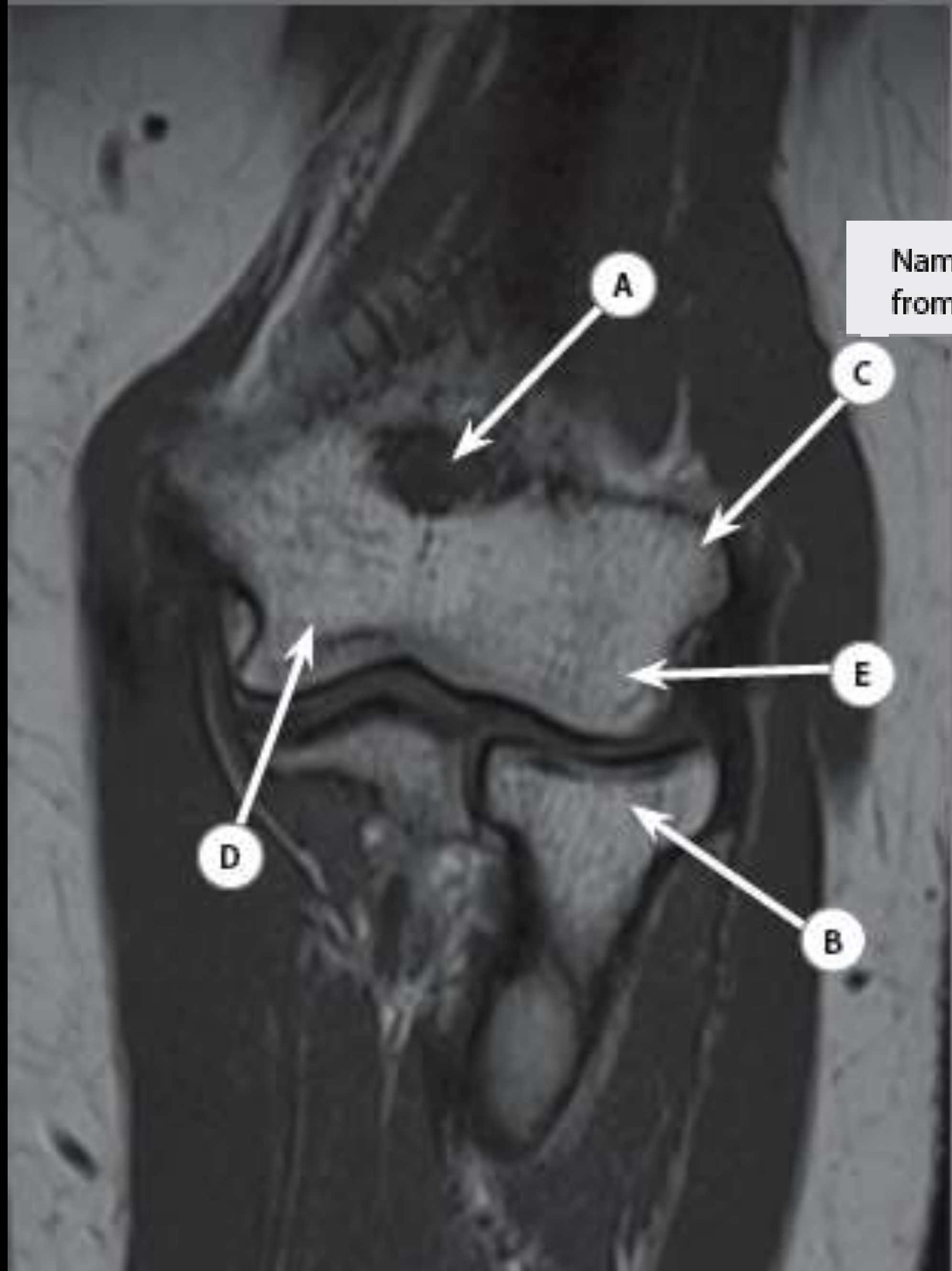
of the forearm. These muscles include the flexor carpi ulnaris and radialis, the palmaris longus and the pronator teres. The action of these muscles is to flex the wrist and elbow joints. Repetitive valgus stress to the elbow (such as in golf and baseball pitching) can cause microtrauma and inflammation of the flexor tendinous insertion, leading to medial epicondylitis, otherwise known as golfer's elbow.

The common extensor tendon is a common tendinous insertion at the lateral epicondyle of the humerus and is shared by a number of extensor muscles of the forearm. These muscles include the extensor carpi radialis, brevis and ulnaris, the extensor digitorum and the extensor digiti minimi. The action of these muscles is to extend the wrist and fingers. Repetitive wrist extension causes microtrauma and inflammation of the extensor tendinous insertion, leading to lateral epicondylitis, also known as tennis elbow.

The anconeus is a small muscle located at the posterior aspect of the elbow that takes its origin at the lateral epicondyle of the humerus and inserts into the olecranon of the ulna. It acts to extend the elbow and tighten the joint capsule.

The ulnar nerve is formed from the medial cord of the brachial plexus (C8–T1) and passes down the posterior aspect of the upper arm. It then courses through the cubital tunnel behind the medial epicondyle of the elbow before continuing through the anterior compartment of the forearm.

Case 9.12



Name the structure that originates from C.

Case 9.12

A Coronoid fossa of the humerus

B Head of radius

C Common extensor tendon

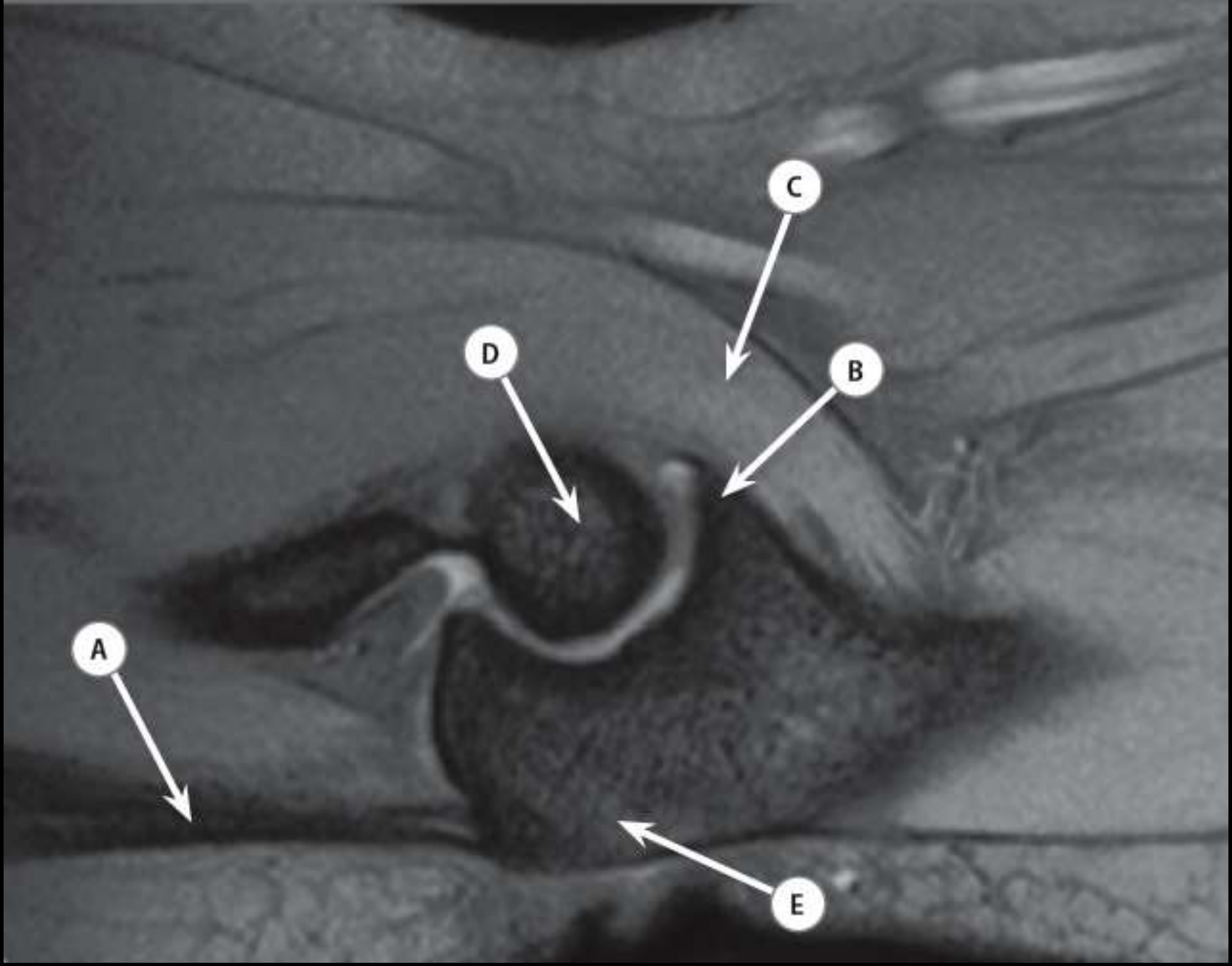
D Trochlea of the humerus

E Capitulum of the humerus

Key osseous anatomy of the distal humerus includes:

1. capitulum – articulates with the head of radius
2. trochlea – lies within the trochlear notch of the proximal ulna
3. medial epicondyle – origin of common flexor tendon
4. lateral epicondyle – origin of common extensor tendon.

Case 15.11



Case 15.11

A Triceps brachii tendon

B Coronoid process of ulna

C Brachialis

D Trochlea of humerus

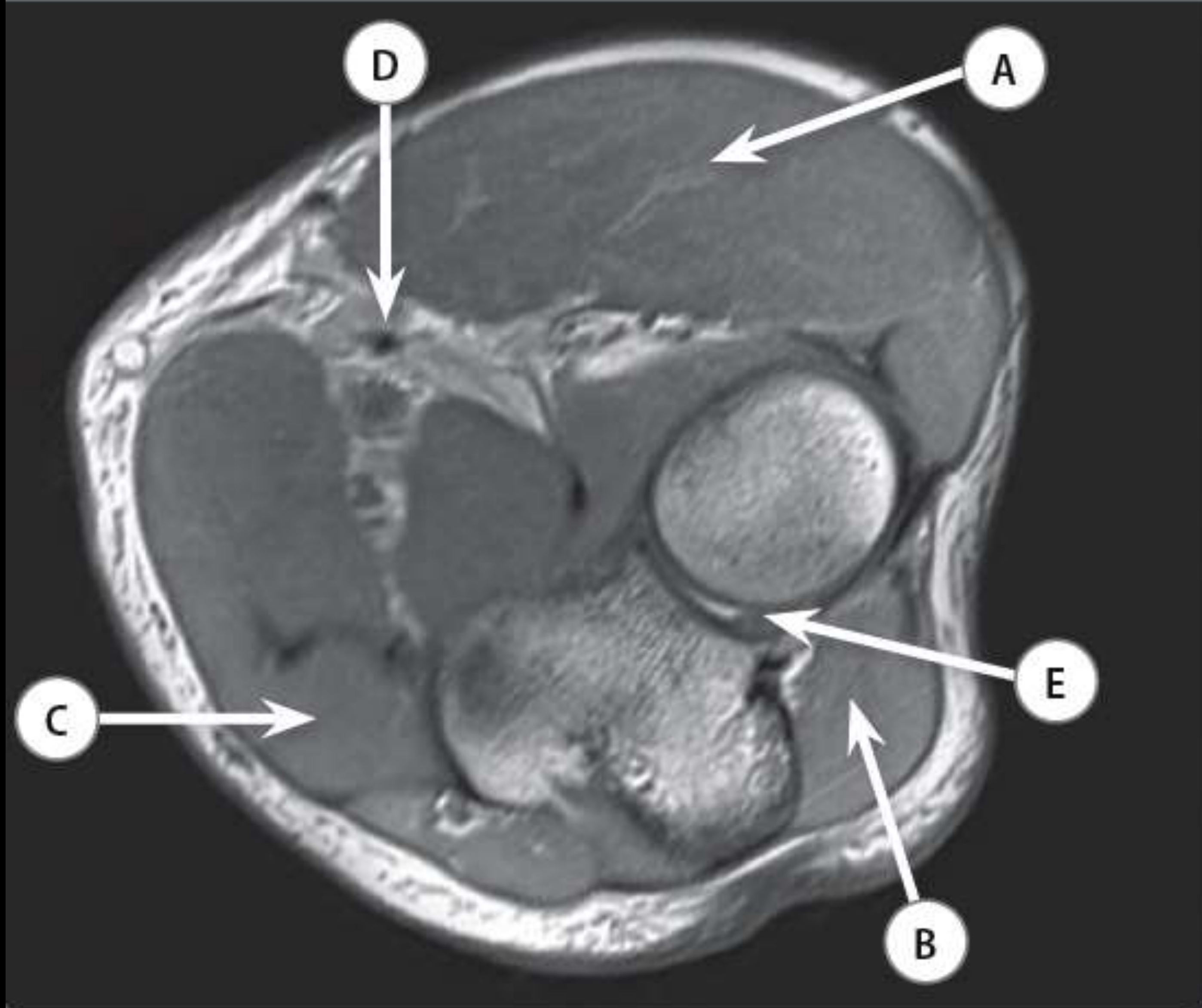
E Olecranon of ulna

This sagittal MRI of the medial aspect of the elbow shows the articulation between the distal humerus and proximal ulna. The trochlea of the distal humerus lies within the trochlear notch of the ulna, the anterior boundary of which is formed by the coronoid process and the posterior boundary by the olecranon.

In elbow extension, the olecranon fills the olecranon fossa of the distal humerus posteriorly. In flexion, the coronoid process fills the coronoid fossa of the humerus anteriorly.

The brachialis muscle is unique in that the bulk of its muscle is seen to cross the elbow joint.

Case 5.12



Case 5.12

A Brachioradialis

B Anconeus

C Flexor carpi ulnaris

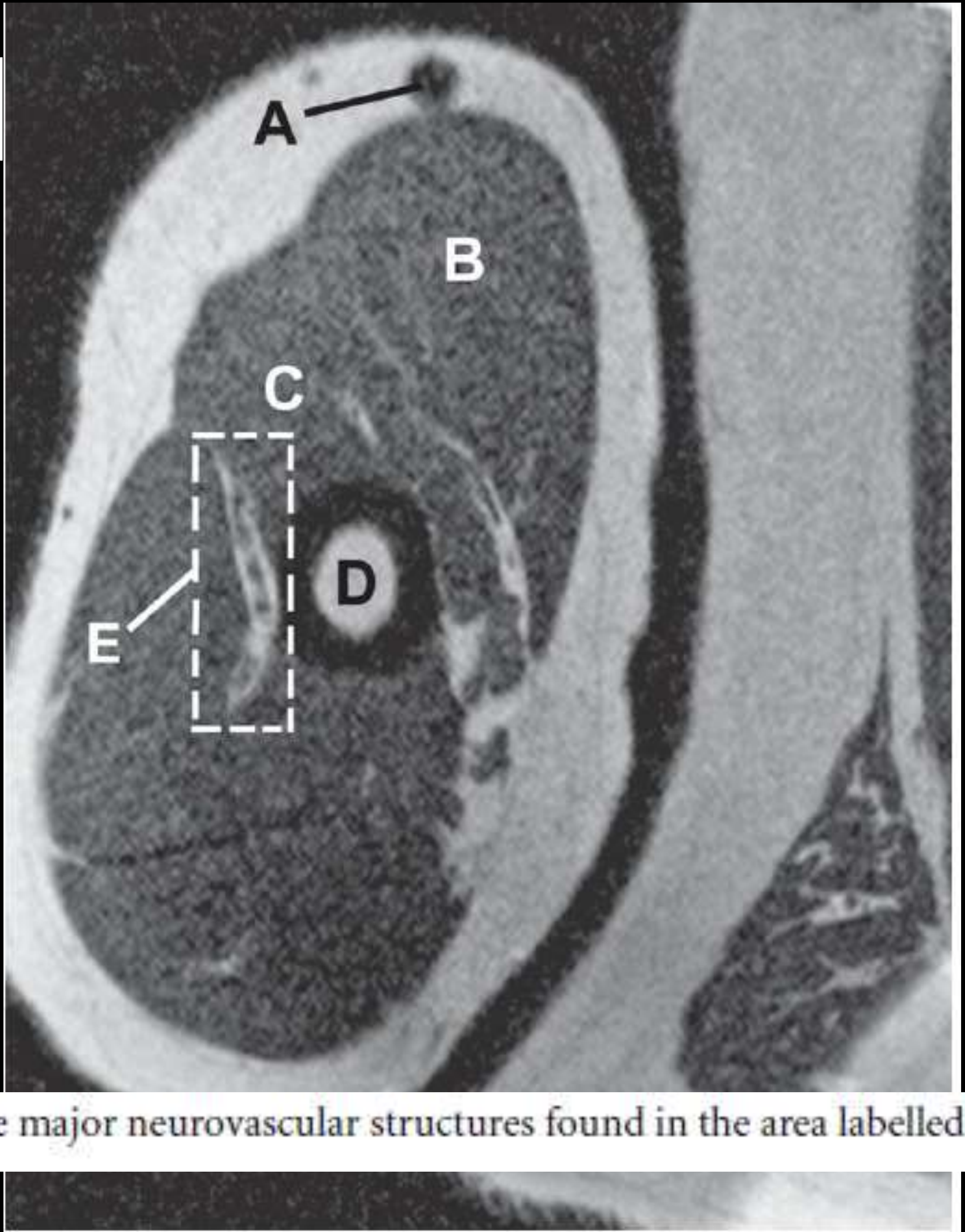
D Median nerve

E Proximal radioulnar joint

Axial MRI of the proximal radioulnar joint.

For further discussion see Chapter 4, Case 4.35.

Q8



e Name the three major neurovascular structures found in the area labelled E

Q8 Answers

- **a** Cephalic vein
- **b** Biceps brachii muscle
- **c** Brachialis muscle
- **d** Medullary cavity of the humerus
- **e** Radial nerve, deep brachial artery(s), deep brachial vein(s)

T1W MRI arm, axial section proximal to the midpoint of humerus

Venous drainage of the arm has superficial and deep components. The major superficial veins are the basilic and cephalic; the cephalic runs anteriorly over the arm while the basilic follows a more medial path. The deeps veins are named after their accompanying arteries.

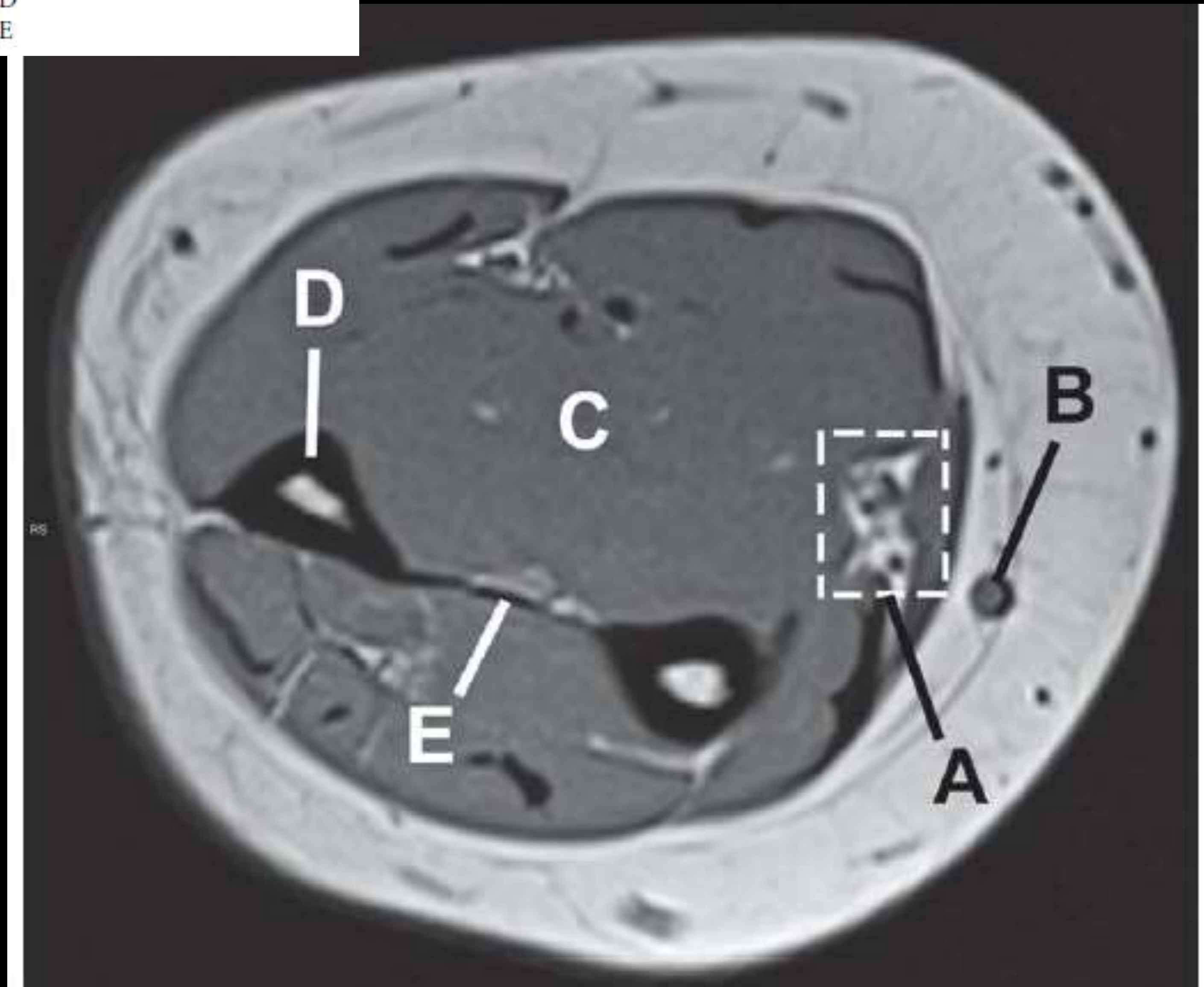
The biceps brachii and brachialis muscles are the forearm flexors; the biceps brachii also acts to supinate the forearm. The arm is divided into anterior and posterior muscle compartments; collectively, biceps brachii and brachialis compose the anterior compartment of the arm. The three heads of the triceps brachii muscle form the posterior muscular compartment. These compartments are separated by medial and lateral intermuscular septi.

The radial nerve runs laterally through the arm posterior to the humerus in the plane between anterior and posterior muscular compartments. The deep brachial artery and vein follow the same course as the radial nerve through the arm at this level.

WRIST

Q14

a Name the group of structures outlined and labelled A
b Name the structure labelled B
c Name the major function of the group of muscles labelled C
d Name the structure labelled D
e Name the structure labelled E



Q14 Answers

a Radial neurovascular bundle (radial artery, nerve and vein)
b Cephalic vein
c Flexion and of the wrist and fingers
d Ulna
e Interosseous membrane

T1W MRI of mid forearm, axial section

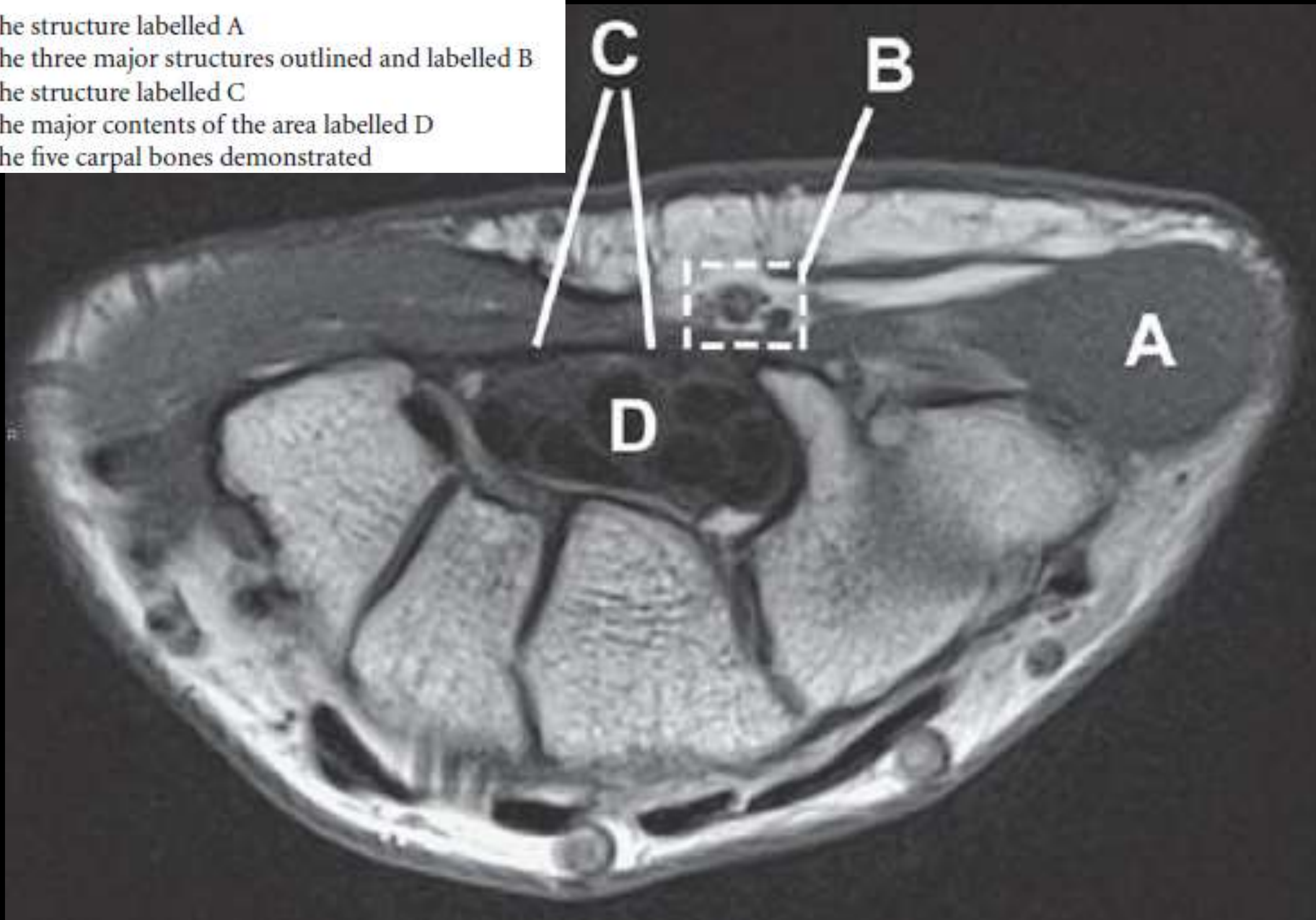
There are three major neurovascular bundles in the forearm; radial, median and ulnar. In addition there are anterior and posterior interosseous bundles; these lie on either side of the interosseous membrane. The radius appears more rounded in cross section when compared with the ulna.

The superficial veins are numerous in the forearm and are found in the subcutaneous fat which is superficial to the deep fascia (the deep fascia covers the muscular compartments). The cephalic and basilic veins are two of the most recognizable superficial veins; the cephalic runs on the lateral side of the arm, while the basilic runs medially. These vessels are continuous throughout most of the arm; they arise from a common plexus of superficial veins on the dorsum of the hand and are joined within the antecubital fossa by the median cubital vein.

Two major muscle groups are functional in the forearm. The flexors lie anterior and as a group are bulkier than the posteriorly situated extensor compartment of muscles.

Q18

a Name the structure labelled A
b Name the three major structures outlined and labelled B
c Name the structure labelled C
d Name the major contents of the area labelled D
e Name the five carpal bones demonstrated



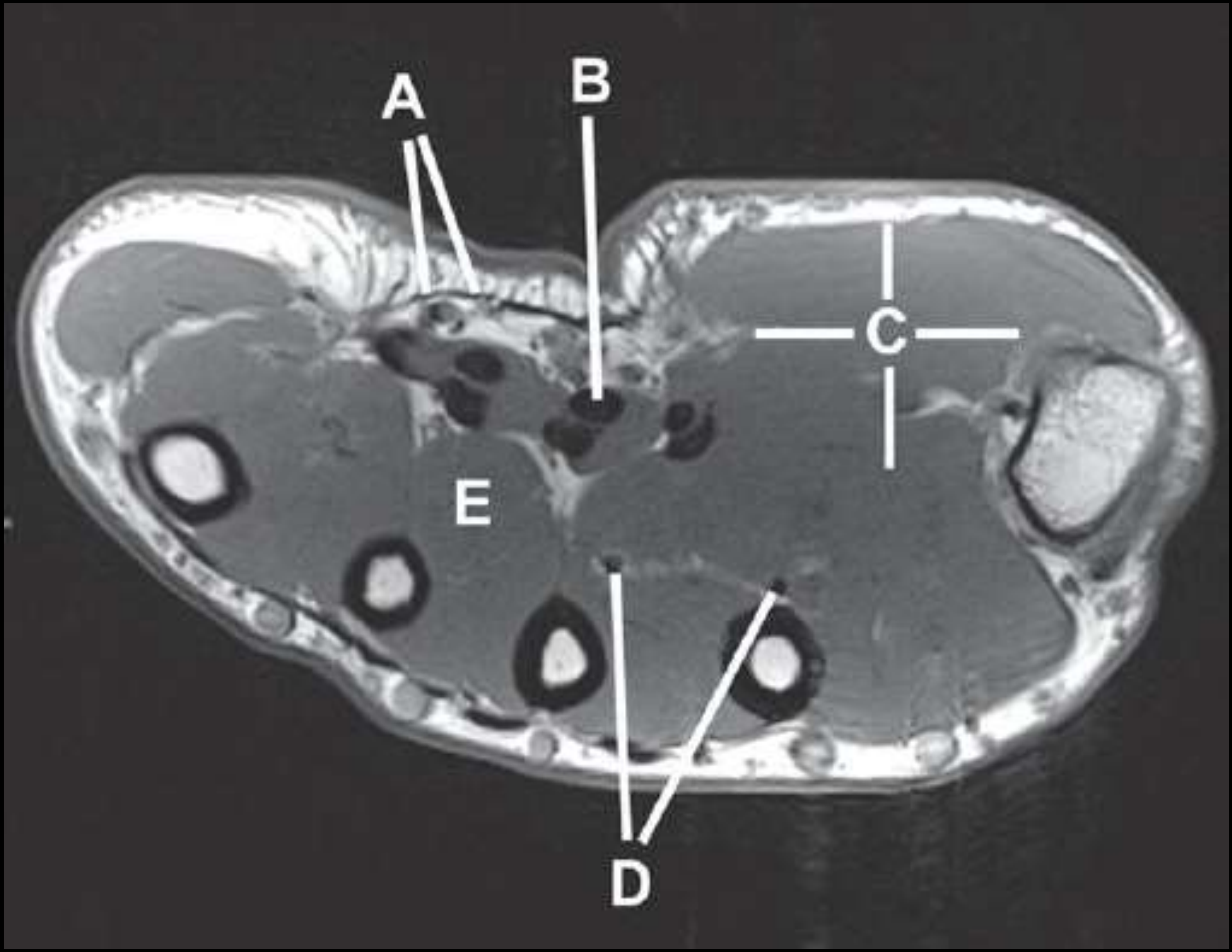
Q18 Answers

a Hypothenar eminence
b Ulnar nerve, ulnar artery and vein
c Flexor retinaculum
d Median nerve, four flexor digitorum superficialis tendons, four flexor digitorum profundus tendons and the tendon for flexor pollicus longus
e Trapezium, trapezoid, capitate, hamate, pisiform (as seen left to right of the image)

T1W MRI of wrist at level of carpal tunnel, axial section

The flexor retinaculum forms the roof of the carpal tunnel and extends from the hook of hamate and pisiform medially to the tubercles of the trapezium and scaphoid laterally. The major contents of the carpal tunnel are the median nerve, the four flexor digitorum superficialis tendons, the four flexor digitorum profundus tendons and the tendon of flexor pollicus longus. The flexor retinaculum can be surgically divided as treatment for carpal tunnel syndrome where there is compressive median nerve neuropathy. Note that the ulnar nerve does not travel through the carpal tunnel and is spared in cases of carpal tunnel syndrome.

There are two muscular prominences on the palmar surface of the hand; the thenar and hypothenar eminences. These muscle groups are responsible for flexion, abduction and opposition of the thumb and little finger (5th digit), respectively.


A
B
C
D
E

Q20 Answers

a Palmar aponeurosis
b Tendon of flexor digitorum superficialis for the middle finger
c Thenar eminence
d Palmar digital arteries
e Lumbrical muscle to ring finger

T1W MRI of hand, axial section through midpoint of metacarpals

The palmar aponeurosis is a thickening of the deep fascia within the palm; it supports and protects structures in the palm.

The median and ulnar nerves terminate in the palm with branches supplying both muscles and skin of the hand. Similarly, the deep and superficial arterial palmar arches give off branches to the hand and fingers; each finger receives blood from a single common palmar digital artery that further divides into medial and lateral proper digital branches. These digital branches run the length of the finger.

Finger flexion is achieved through the action of several muscles. The long flexors of the fingers are the flexors digitorum superficialis (FDS) and profundus (FDP). There are four tendons for each (one to each finger) with the profundi lying deep to the supericialis throughout their course. For each of the four digits, the tendon of FDS splits and is attached to the sides of the middle phalynx. Through this split passes the tendon of FDP on its way to the base of the distal phalynx. The long flexors act upon the interphalangeal joints. Arising in the palm from the tendons of FDP are four palmar muscles known as the lumbricals which provide flexion at the metacarpal-phalyngeal joints. The lumbrical muscles are situated superficially to the interosseous muscles which fill the spaces between the metacarpals.

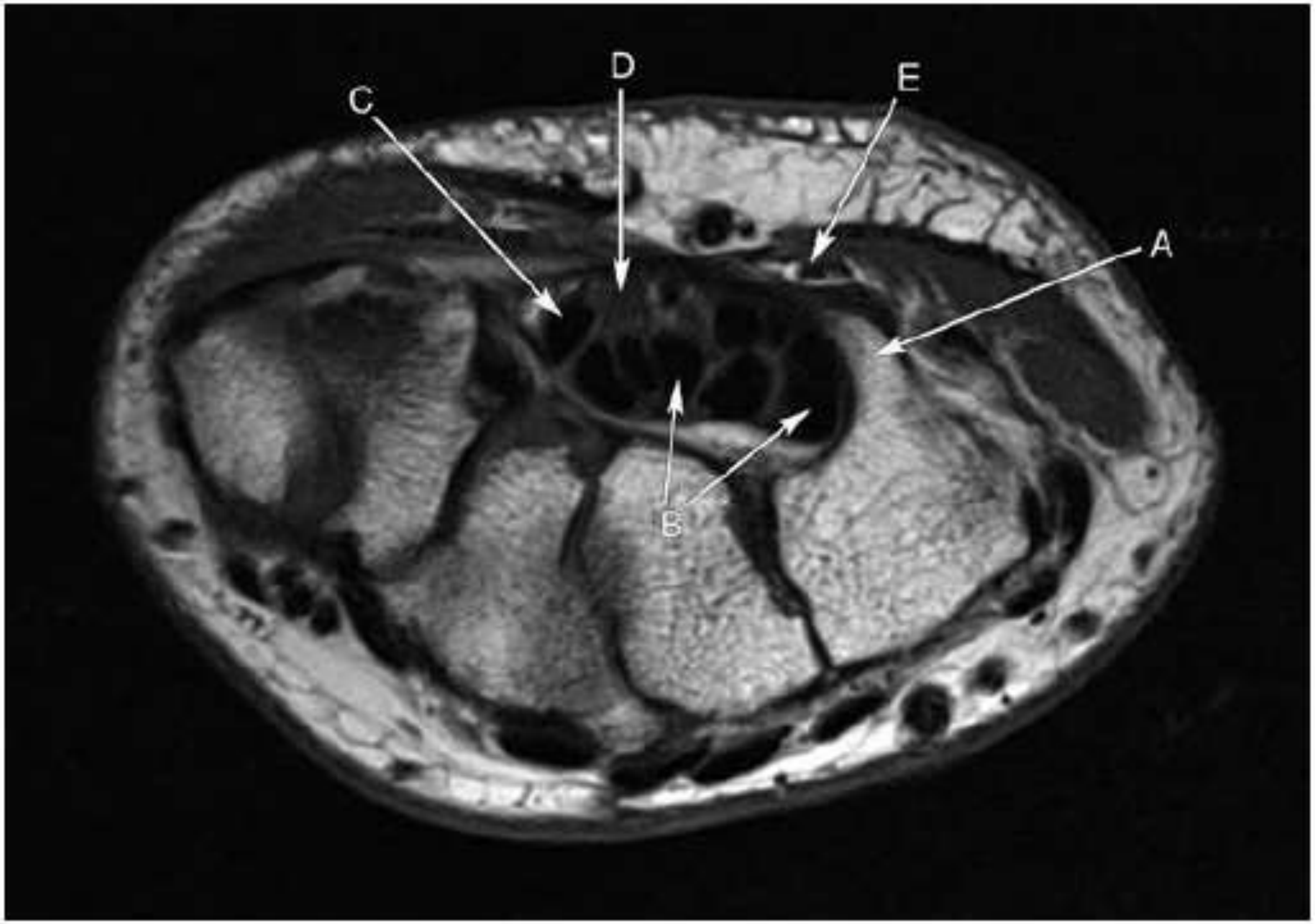
Question 28:

Question 28: Coronal MRI of the wrist

Answer: Triangular fibrocartilaginous complex

- As the name suggests, the triangular fibrocartilaginous complex is composed of a fibrocartilaginous articular disc with ligaments that originate from the medial border of the distal radius and inserts into the ulna styloid.
- It is triangular in shape and serves as the main stabilizer of the distal radioulnar joint and supports the distal carpal row.

Question 5.20



This is an axial MRI of the right wrist.
Name the structures labelled A to D.
E What structures pass through E?

5.20 Axial T1 MRI of the right wrist

A Hook of the right hamate.
B Tendons of right flexor digitorum profundus.
C Tendon of right flexor pollicis longus.
D Right median nerve.
E Right ulnar nerve and artery (the structure labelled is Guyon's canal).

The carpal tunnel is the fibro-osseous pathway on the palmar side of the wrist that connects the distal forearm to the deep palm. It is superficially bounded by the flexor retinaculum, which attaches medially to the pisiform and the hook of the hamate bone, and laterally to the scaphoid and trapezium. The carpal tunnel is a tight space containing ten structures in total:

- Nine flexor tendons.
- Four × flexor digitorum profundus.
- Four × flexor digitorum superficialis.
- Flexor pollicis longus.
- Median nerve.

Within the carpal tunnel, the median nerve lies superficially with respect to the tendons.

The ulnar nerve and artery pass through a separate channel, known as Guyon's canal.

Question 7.19

This is a coronal MRI of the left wrist.
Name the structures labelled **A** to **E**.

7.19 Coronal T1 MRI of the left wrist

A Extensor carpi ulnaris tendon.
B Triangular fibrocartilage.
C Ulna.
D Trapezium.
E Flexor digitorum profundus tendons.

The triangular fibrocartilage complex (TFCC) refers to the ligamentous and cartilaginous structures that lie between the ulna and the carpal bones (lunate and triquetrum). It is the major ligamentous stabilizer of the distal radio-ulnar joint and the ulna carpus, and acts to provide smooth gliding articulation of the wrist joint. The predominant component of the triangular fibrocartilage complex is a triangular wedge-shaped fibrocartilagenous disc bridging the distal radioulnar joint. The triangular fibrocartilage is a biconcave disc separating the radiocarpal and distal radioulnar joint spaces. It is the only structure of the triangular fibrocartilage complex consistently visualized on MRI.

Question 9.7

9.7 Sagittal STIR MRI of the right wrist

A Tendon of flexor digitorum superficialis.
B Tendon of flexor digitorum profundus.

C Lunate.
D Capitate.
E Base of the third metacarpal.

The tendons of the flexor digitorum profundus (FDP) run deep to the tendons of the flexor digitorum superficialis (FDS), and insert distally to the tendons of the flexor digitorum superficialis. The four tendons of the flexor digitorum superficialis (one for each finger apart from the thumb) each divide to allow passage of the tendons of the flexor digitorum profundus and then reunite distally to insert into the palmar aspect of the bases of the second to the fifth middle phalanges. The tendons of the flexor digitorum profundus continue to insert into the palmar aspect of the base of the second to the fifth distal phalanges.

For an explanation of the alignment of the carpal bones in the sagittal plane see Question 4.16.

Question 9.9

9.9 Coronal CT of the wrist

A Right hamate.
B Right triquetral.
C Right second metacarpal.
D Right trapezoid.
E Right radial styloid.

For a table of the carpal bone ossification ages, please see Question 10.13.

Question 10.16

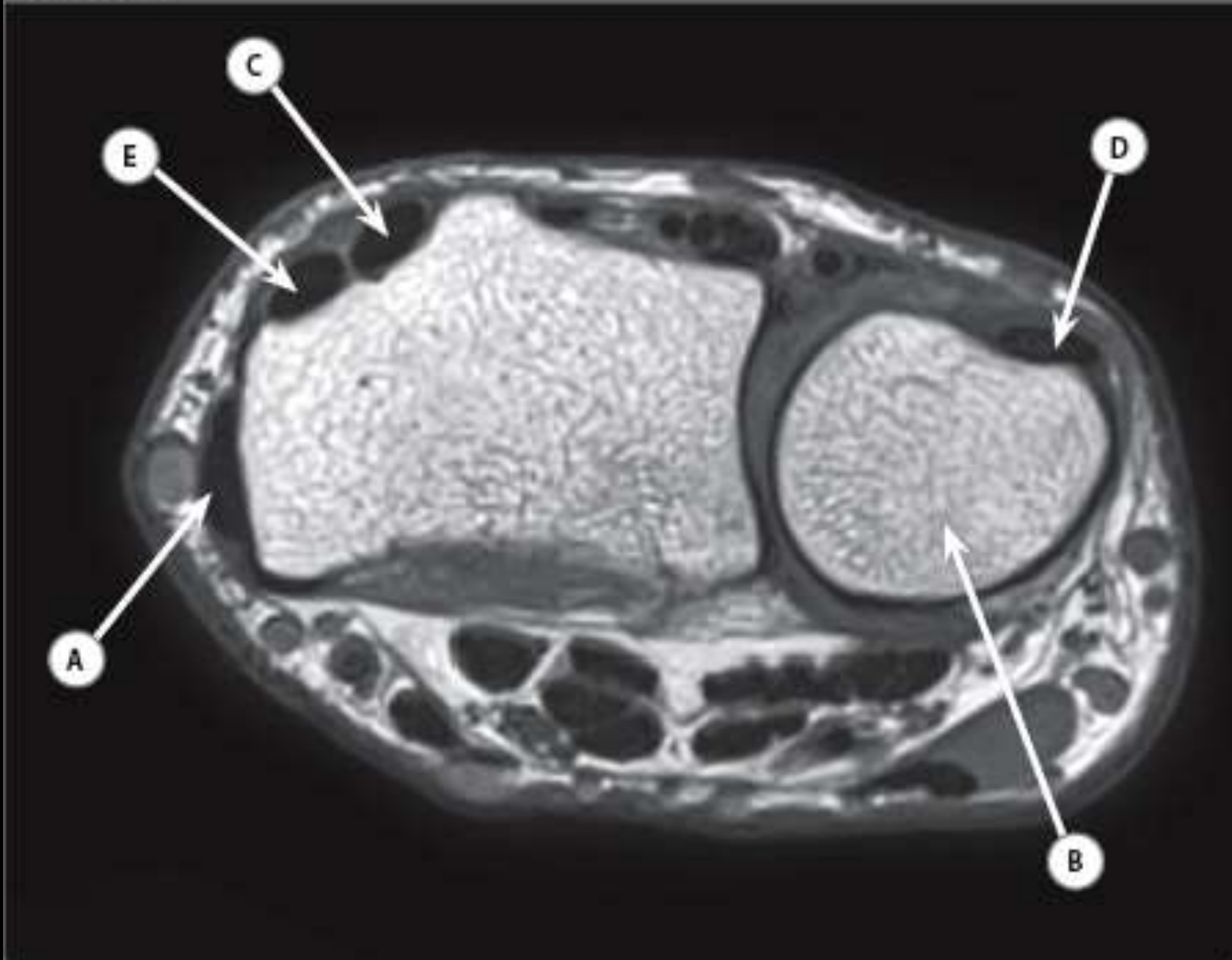
10.16 Coronal T1 MRI of the right wrist

A Tendon of flexor digitorum profundus.
B pisiform.
C lunate.
D trapezium.
E Tendon of flexor pollicis longus.

Within the carpal tunnel, the tendons of the flexor digitorum profundus (FDP) and flexor pollicis longus (FPL) run in the same plane and deep to the tendons of the flexor digitorum superficialis (FDS). This image is at the level of the carpal bones and therefore must be at the level of the flexor digitorum profundus.

For more information on the carpal tunnel and the tendons of the flexor digitorum profundus and flexor digitorum superficialis, see Questions 5.20 and 9.7.

Case 5.16



Case 5.16

A Abductor pollicis longus tendon or (other acceptable answer) extensor pollicis brevis tendon

B Distal ulna

C Extensor carpi radialis longus tendon

D Extensor carpi ulnaris tendon

E Extensor carpi radialis brevis tendon

The tendons of the dorsal wrist are separated into six fibro-osseous compartments. They include (from radial to ulnar):

1. Abductor pollicis longus and extensor pollicis brevis tendons
2. Extensor carpi radialis longus and brevis tendons
3. Extensor pollicis longus tendon
4. Extensor digitorum and extensor indicis tendons
5. Extensor digiti minimi tendon
6. Extensor carpi ulnaris tendon – lies within the distal ulnar groove.

The dorsal tubercle of the radius, Lister's tubercle, is a helpful osseous landmark between the extensor carpi radialis tendons (second compartment) and the extensor pollicis longus tendon (third compartment).

Case 7.19

Case 7.19

A Base of third metacarpal

B Distal radius

C Lunate

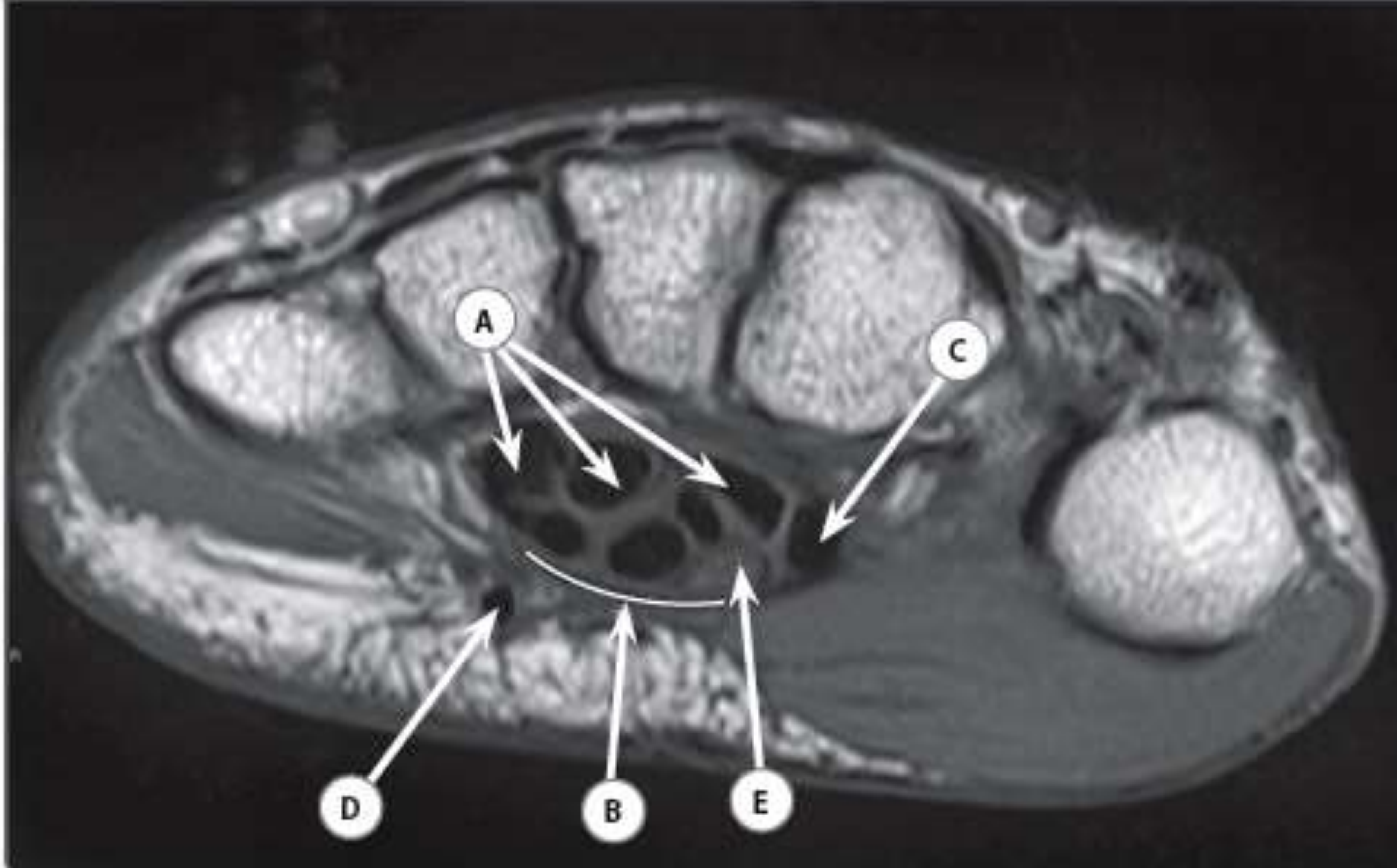
D Flexor digitorum superficialis tendon

E Capitate

This selected sagittal MRI of the wrist demonstrates the straight alignment of the distal radius, lunate, capitate and base of the third metacarpal. If this alignment is disrupted, one must consider a lunate or perilunate dislocation has occurred.

TIP: there is more soft tissue 'padding' on the palmar aspect of the hand in comparison with the dorsal aspect. When trying to determine if an extensor or flexor tendon is labelled, remember that flexors will be on the 'thicker' side of the hand, i.e. the palmar aspect.

Case 10.20



Case 10.20

A Flexor digitorum profundus tendons

B Flexor retinaculum

C Flexor pollicis longus tendon

D Ulnar artery

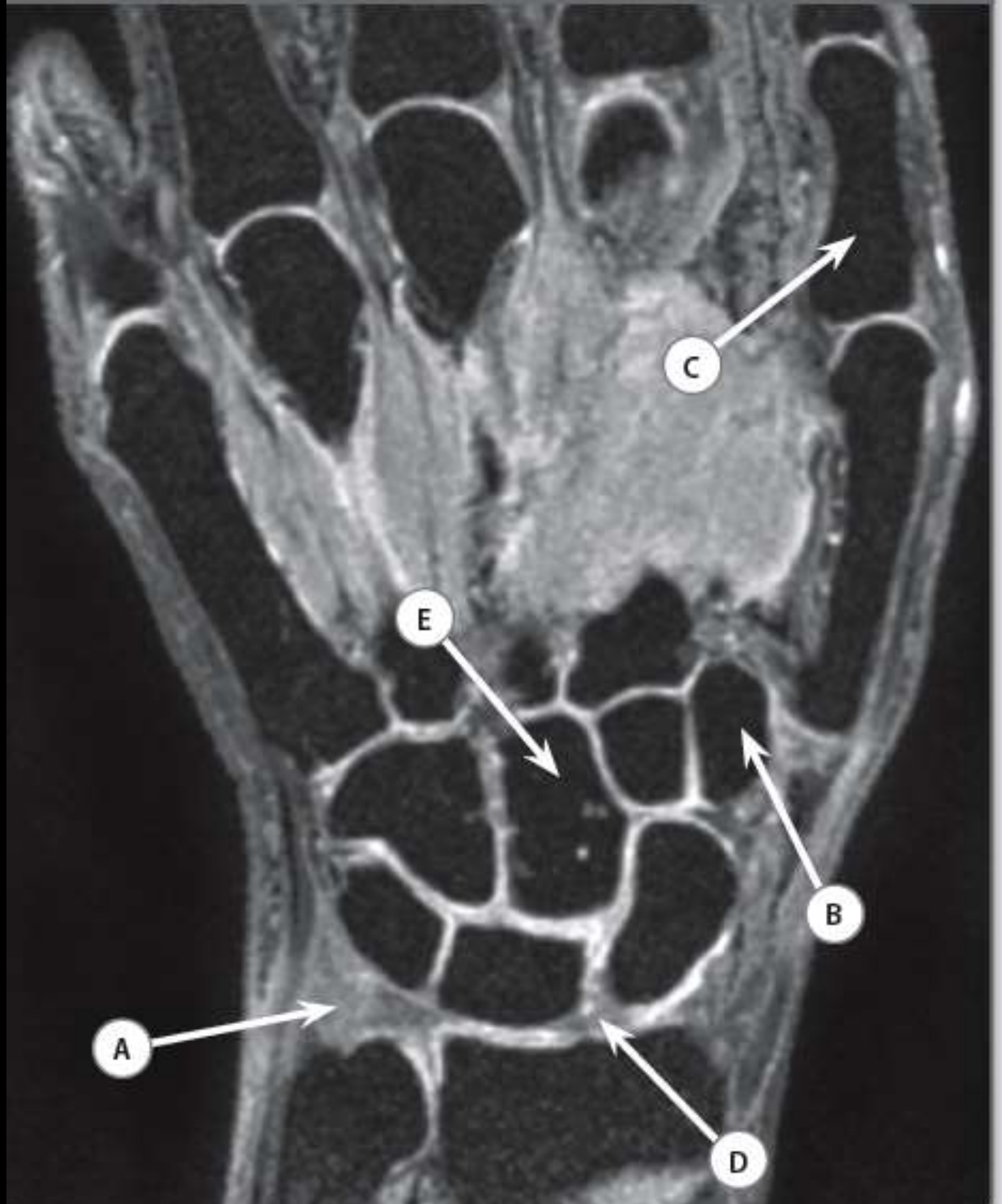
E Median nerve

The carpal tunnel is a fibro-osseous space situated in the ventral aspect of the wrist. The deep boundary is formed by the volar aspect of the carpal bones and the more superficial boundary is formed by the dense fibrous flexor retinaculum. The carpal tunnel contains:

1. the median nerve – fasciculate appearance
2. four flexor digitorum profundus tendons
3. four flexor digitorum superficialis tendons
4. the flexor pollicis longus tendon

Guyon's canal is a space within the wrist which lies between the pisiform and hamate, through which the ulnar artery and ulnar nerve run to the hand.

Case 12.2



Case 12.2

A Triangular fibrocartilage complex

B Trapezium

C Proximal phalanx of the thumb

D Scapholunate ligament

E Capitate

Mnemonic for the carpal bones:

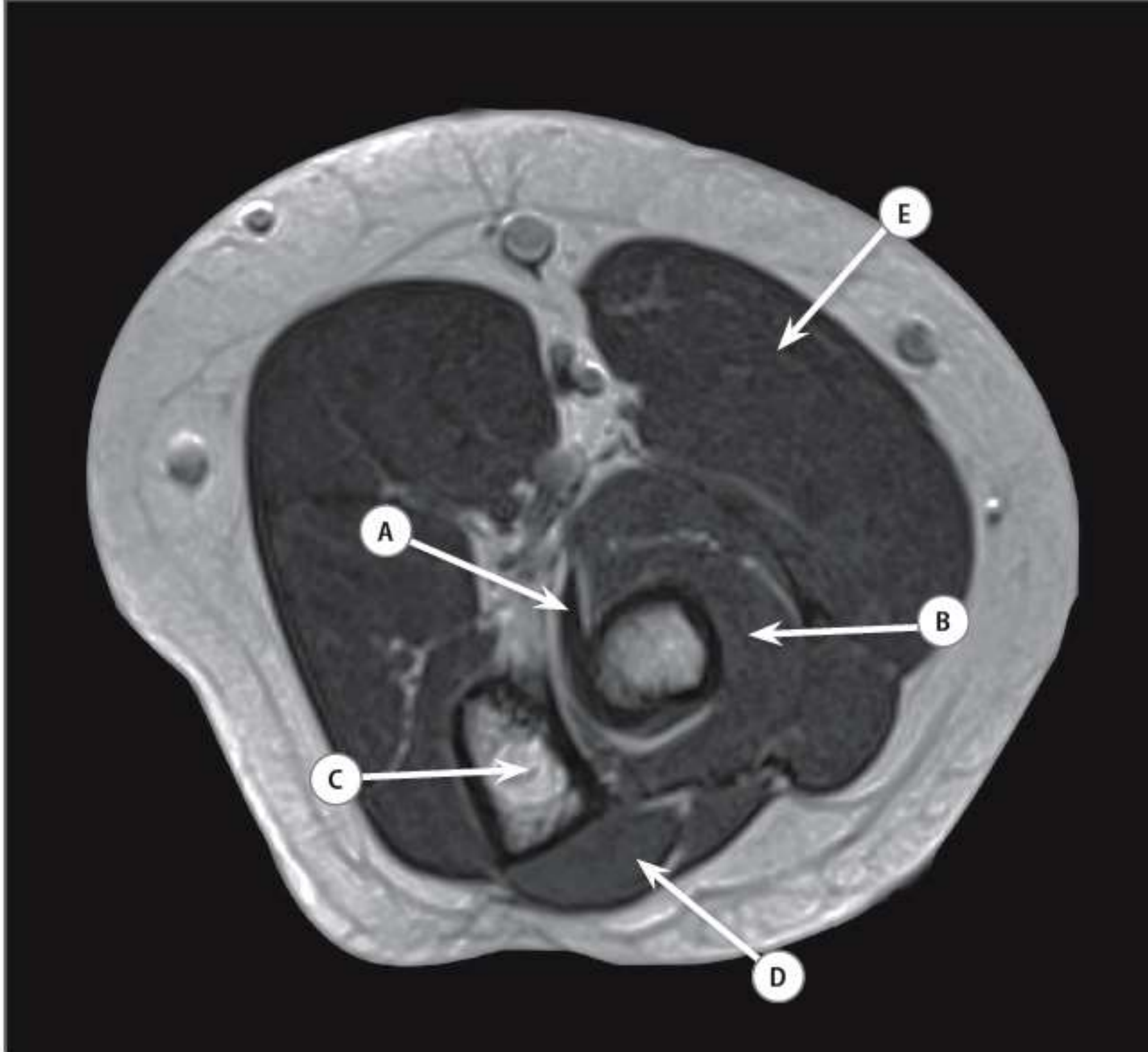
Scared Lovers Try Positions That They Cannot Handle

Proximal carpal row (from radial to ulnar)
Scaphoid, Lunate, Triquetral, Pisiform

Distal carpal row (from radial to ulnar)
Trapezium, Trapezoid, Capitate, Hamate

Remember – trapeziUM is by the thUMb (the thUMb swings on the trapeziUM).

Case 15.2



Case 15.2

A Tendon of biceps brachii muscle

B Supinator muscle

C Ulna

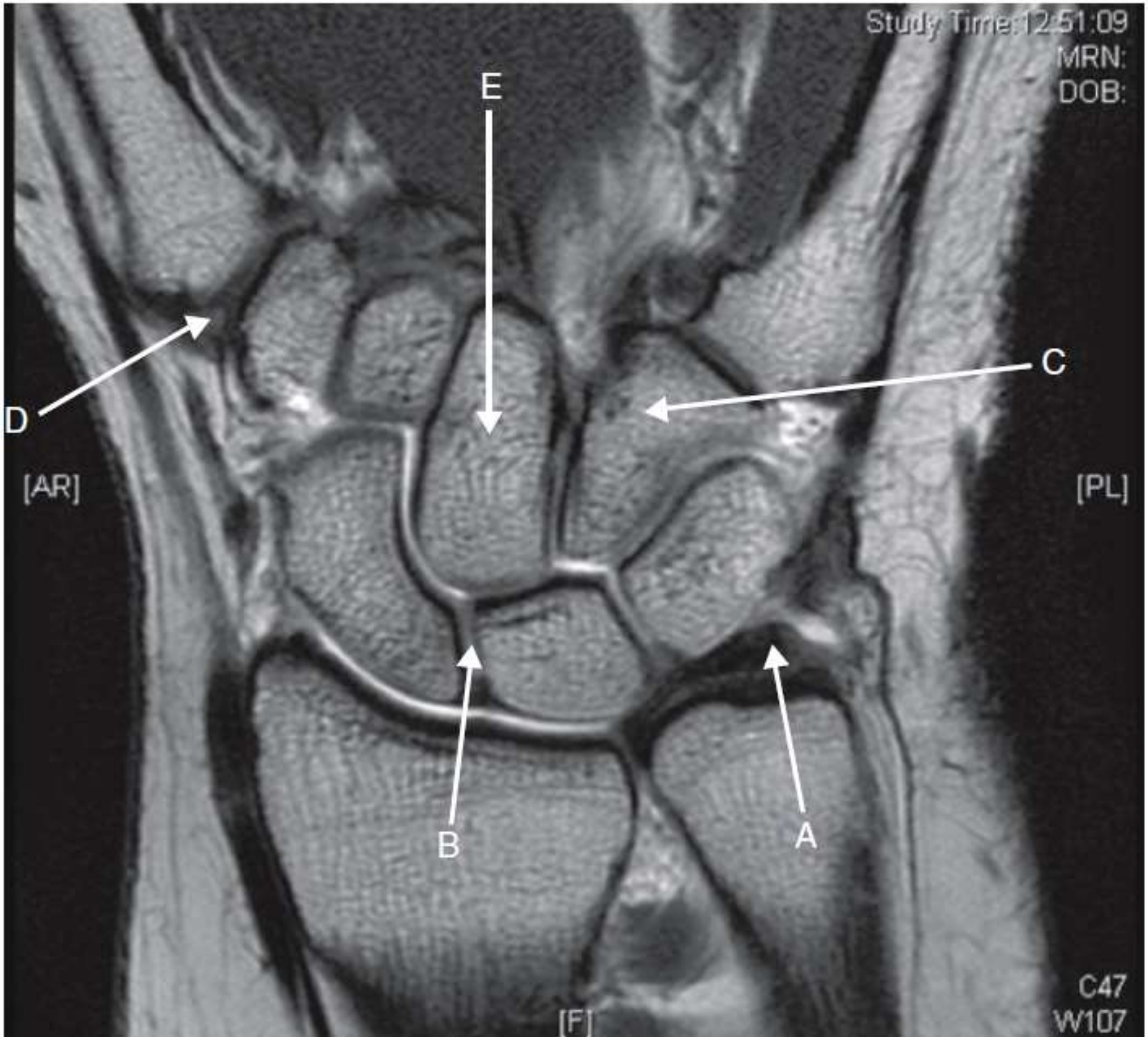
D Anconeus muscle

E Brachioradialis muscle

Axial anatomy of the forearm may be difficult. Here are a few aide-mémoires to help you with memorising some key structures.

- the supinator muscle wraps around the proximal radius
- anteriorly, the most lateral muscle of the proximal forearm is brachioradialis
- anteriorly, the most medial muscle of the proximal forearm is pronator teres
- the anconeus muscle is seen posterior to supinator and is wedged between the proximal ulna and radius posteriorly.

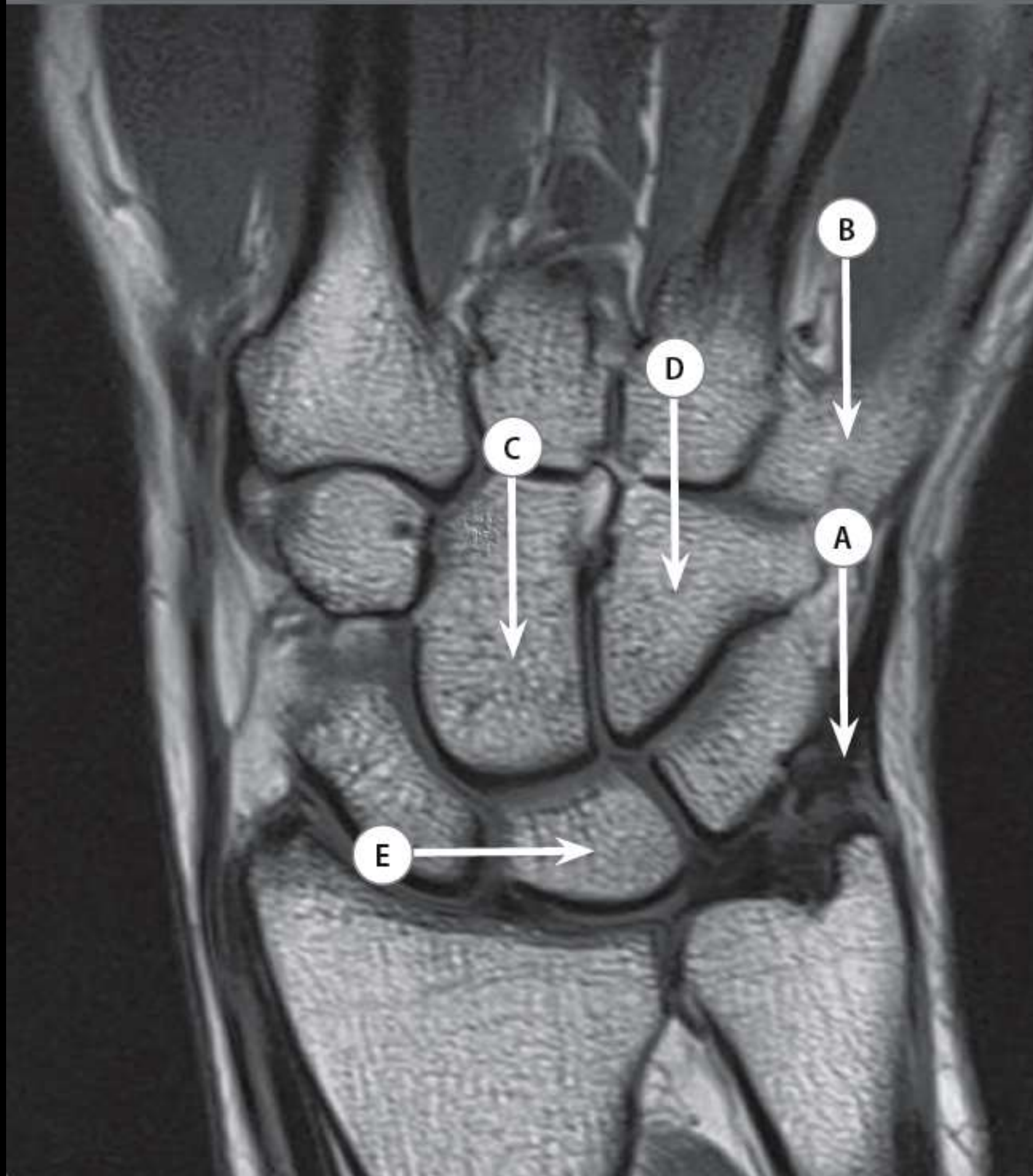
Case 3.10



3.10 Coronal T1-weighted MR wrist

(a) Triangular fibrocartilage. This fibrocartilaginous disc contributes to stability of the distal radio-ulnar joint (DRUJ). Degenerative and traumatic tears of this structure are common causes of mechanical ulnar sided wrist pain.
(b) Scapho-lunate (SL) ligament. This short ligament is made up of volar, central and dorsal components, which contribute to stability of the proximal carpal row. Tears of the SL ligament lead to volar-flexion of the scaphoid and dorsi-flexion of the lunate producing a dorsal intercalated segment instability (DISI) appearance on lateral radiographs.
(c) Hamate. This bone occupies the distal carpal row, articulating with the fourth and fifth metacarpals. It possesses a hook-shaped process on its volar surface which bears an attachment of the flexor retinaculum. The hook may become fractured following falls onto the palm, particularly whilst holding racket handles.
(d) Carpo-metacarpal joint of the thumb. This is a synovial saddle joint which is a common site for early osteoarthrosis in the hand.
(e) Capitate. This is the largest carpal bone and the first to ossify.

Case 6.13



Case 6.13

A Triangular fibrocartilage

B Base of little finger metacarpal

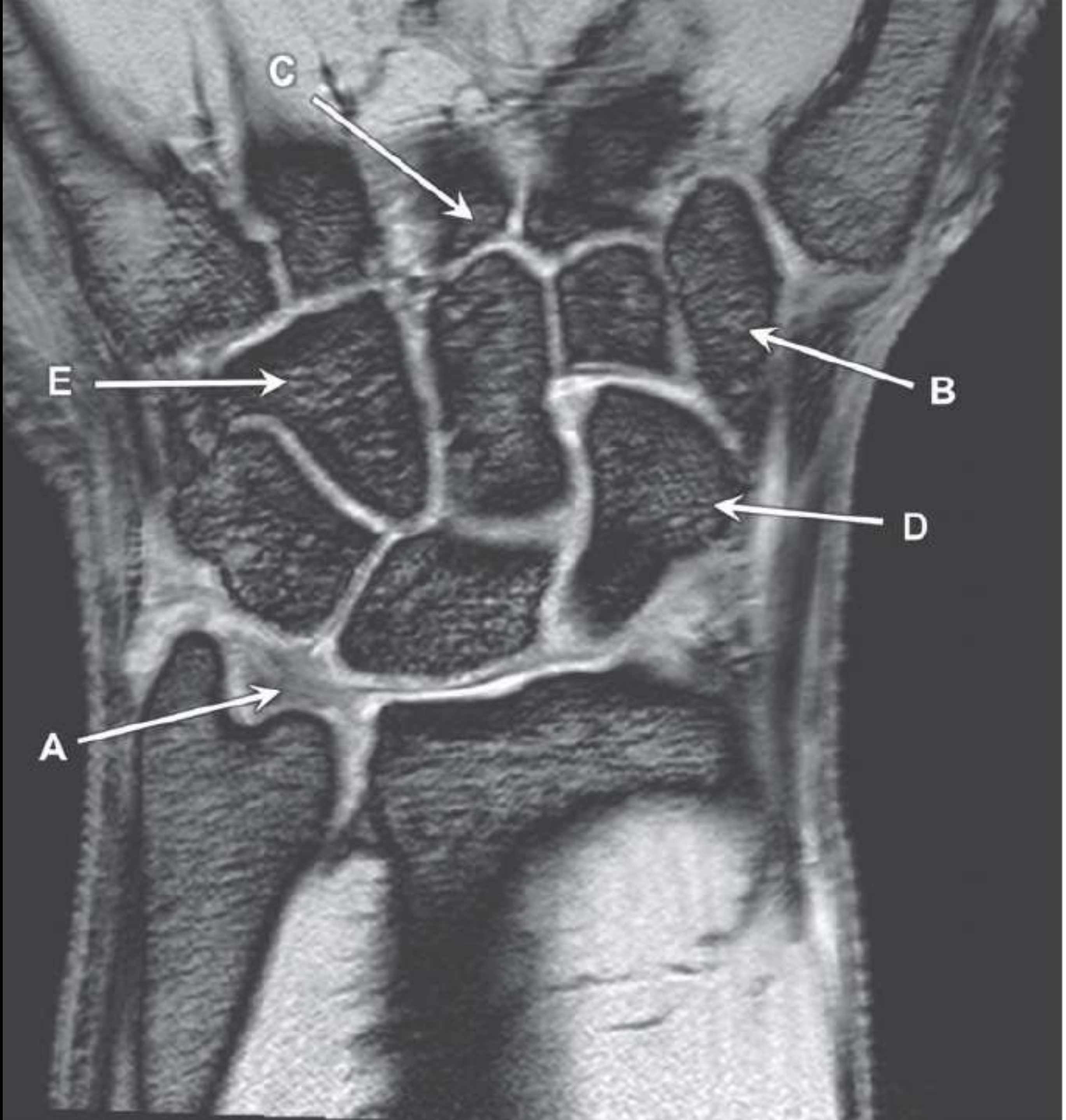
C Capitate

D Hamate

E Lunate

MRI of the carpal bones.

For further discussion see Chapter 4, Cases 4.32 and 4.33.



C
E
B
D
A

Case 4

MR wrist, coronal section, T1 weighted.

1. Triangular fibrocartilage
2. Trapezium
3. Base of third metacarpal bone
4. Scaphoid
5. Hamate

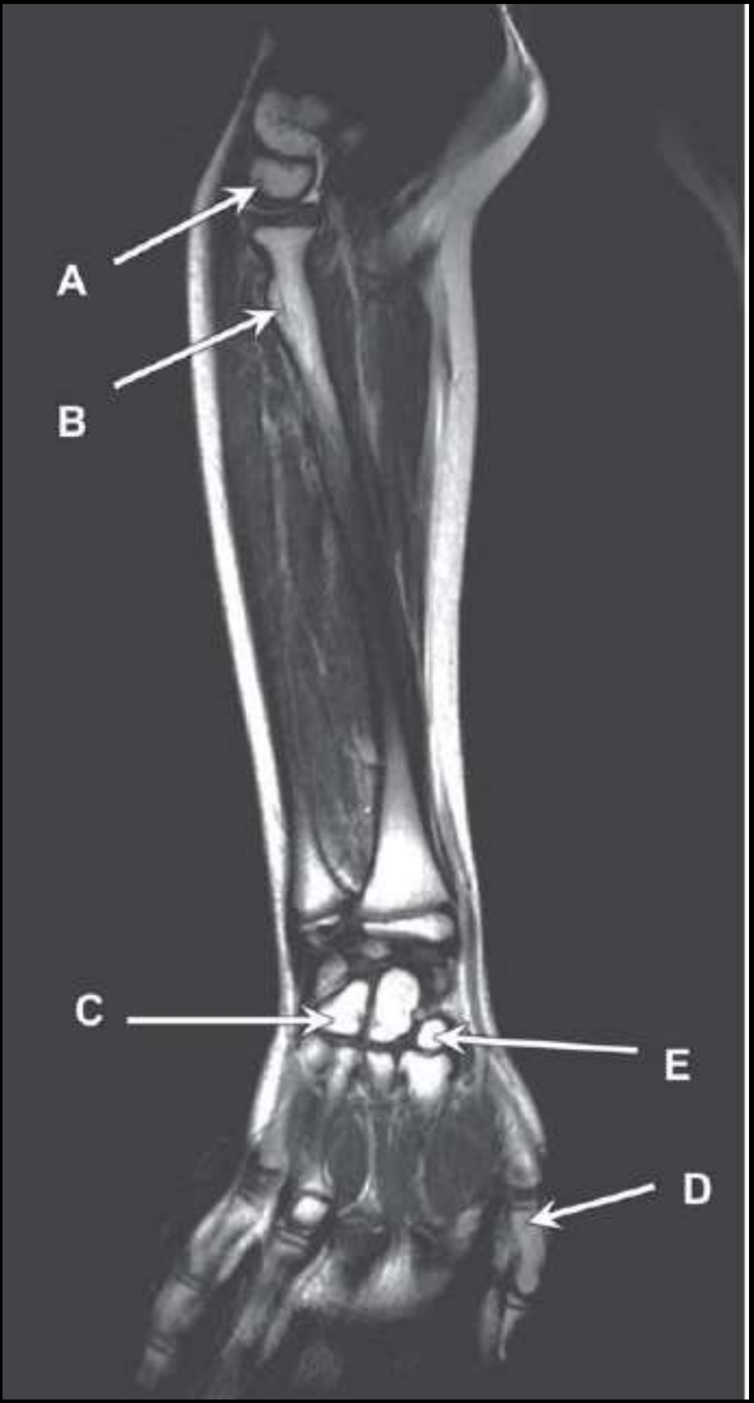
A
E
C
D
B

Case 15

MRI wrist. Volar aspect. Coronal section.

1. First (or thumb) metacarpal bone
2. Radial artery
3. Hook of the hamate
4. Pisiform bone
5. Trapezium bone

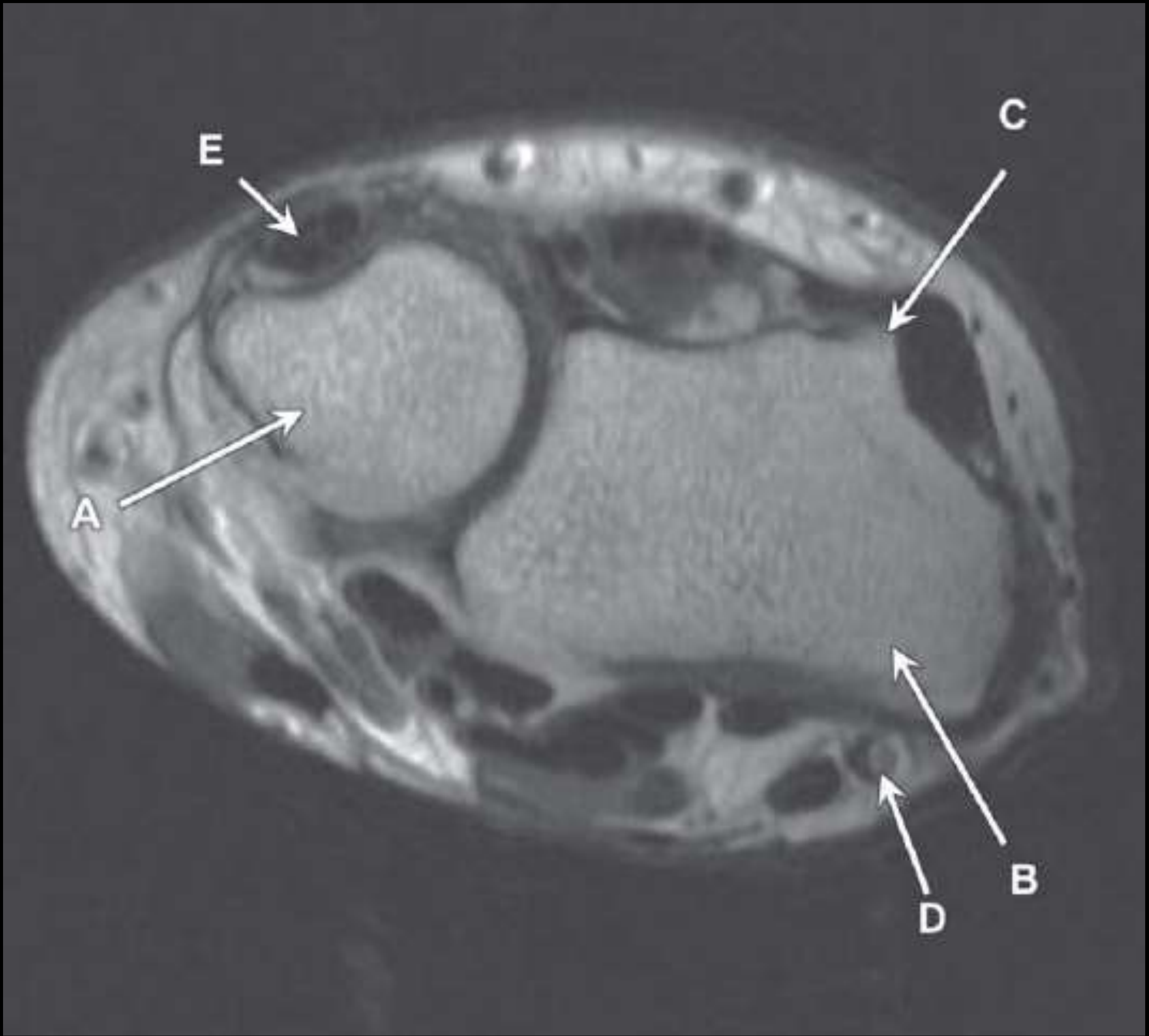
Identifying this as the wrist may be the most difficult part; once this is done, the rest is straightforward. There is nowhere else in the body where so many tendons come together through such a narrow tunnel (and the base of thumb should be recognizable). Note that 'B' shows flow artefact distally so is a vessel, not a tendon.


A
B
C
E
D

Case 5

MRI forearm. T2W coronal section.

1. Capitulum of humerus
2. Tuberosity of radius
3. Hamate
4. Proximal phalanx of thumb
5. Trapezoid

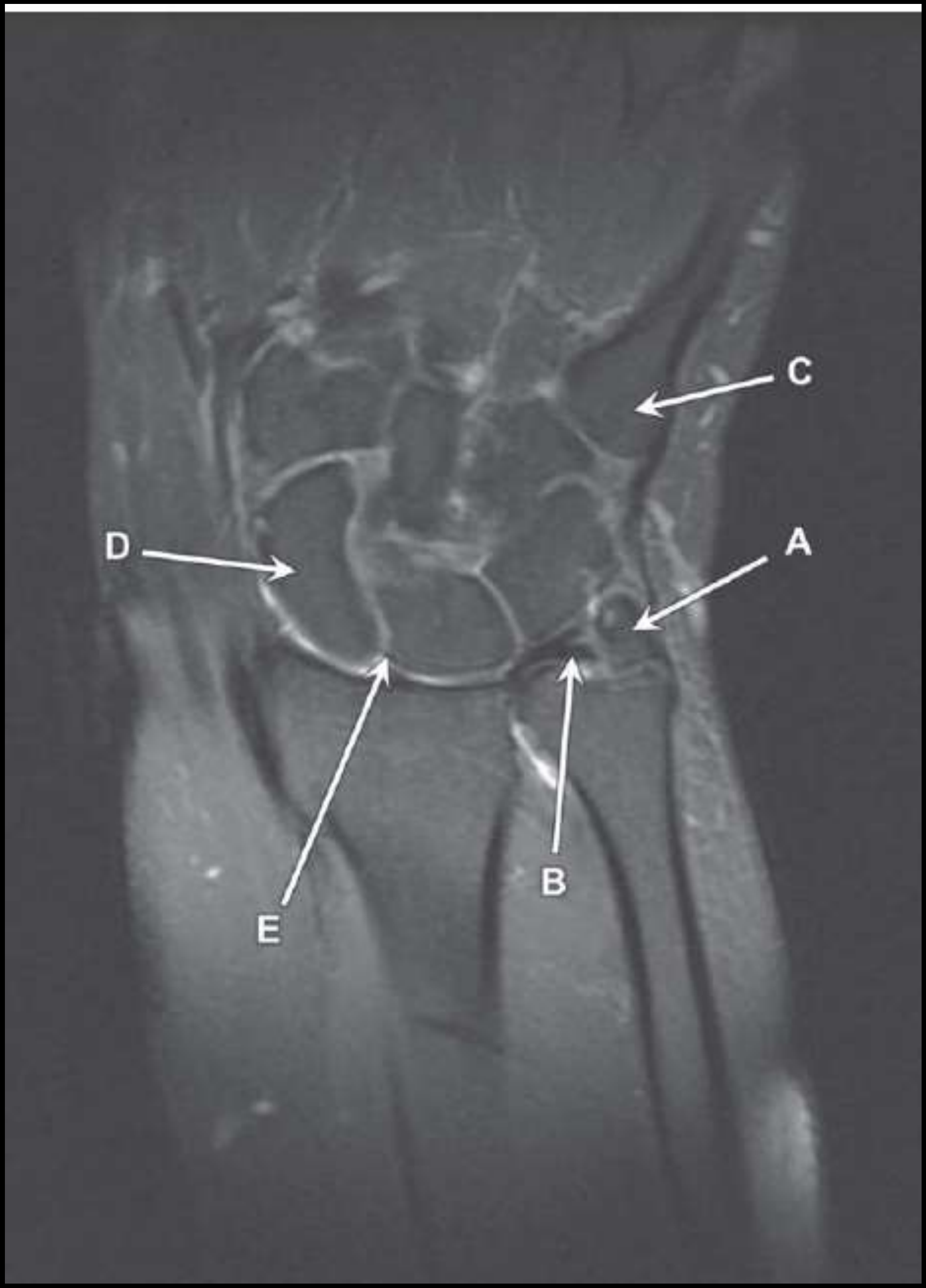

E
C
A
B
D

Case 14

MRI wrist. Axial image at the level of the distal radius.

1. Ulna
2. Radius
3. Dorsal tubercle of radius/ Lister's tubercle
4. Radial artery
5. Tendon of extensor carpi ulnaris muscle

A difficult case. The radial artery is clearly different to the other rounded structures being circular rather than ovoid on this section and showing flow void artefact rather than a solid low signal.


C
D
A
B
E

Case 6

MRI wrist. Coronal T2W image.

1. Ulnar styloid
2. Triangular fibrocartilaginous disc
3. Base of fifth metacarpal
4. Scaphoid
5. Scapholunate ligament